SCIENCE

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MSS. intended for publication and books etc., intended for review should be sent to the responsible editor, Prof. J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*A MEMORIAL APPRECIATION OF CHARLES VALENTINE RILEY.**

THE name of Charles Valentine Riley is known in every part of the world where there are naturalists or intelligent agriculturists. His contributions to biological science and to agricultural economy were extensive and important, and were very highly esteemed abroad as well as at home.

At the time of his death he was fifty-two years old. Those who have known him only in recent days cannot have a full appreciation of many of his most characteristic and attractive traits. During the last ten years, worn out by intense devotion to his work, his energies exhausted by incessant application, his nervous vitality depleted by the friction of a long and arduous official career, though still remarkable for his force and productiveness, he was by no means the same as in the fourth decade of his life.

When, in 1894, he resigned his position as chief of the Bureau of Entomology, it was the belief and hope of his friends that, relieved from the official burden which had become so irksome to him, he would be able to devote the remainder of his life entirely to scientific pursuits. With his vast learning, his experience as an investigator, and the opportunities for leisurely study

* Presented at the annual meeting of the Joint Commission of the Scientific Societies of Washington, January 18, 1896.

which he possessed, it seemed as if the most useful period of his life was just about to begin. Many who are here present will remember the dinner given in his honor shortly after his fiftieth birthday, and how bright and promising his future then seemed. His untimely death prevented the realization of our anticipations; but yet, now that we can survey his career and review with care his achievements, it does not seem credible that they are those of one suddenly cut down in the prime of his life.

They are rather those of a man who, having lived to a good old age, had accomplished the work of fully two men during each year of his activities.

His energy was boundless and untiring; he did with ease and facility whatever he attempted, and rarely failed to accomplish that which he had undertaken to do; he had rare ability in selecting and training men to do the work for which he had himself no time, and in directing their labors towards the speedy attainment of results.

He acquired in early life those habits of feverish and restless activity which are characteristic of many of our countrymen, and which, though they contributed materially to magnify the results which he accomplished within comparatively few years, undoubtedly shortened the period of his usefulness.

The vast amount of work which he accomplished is shown by the catalogue of his published papers, of which there are more than 1,600, many of them of very considerable extent, and the whole equivalent to at least 20,000 octavo pages.

Professor Riley was a man of singularly striking appearance and agreeable presence. No one who had once seen him could forget him. Active and graceful, his bearing was such that, though perhaps not more than five feet ten inches in height, he seemed much taller. He never lost the easy, independent carriage which he had acquired during his early life in the West, and there was always something unconventional and picturesque about his costume and appearance. The broad-brimmed, sombrero-like hat, dark in winter, light in summer, which he almost always wore, seemed in keeping with his swarthy complexion. He looked like an artist or a musician, and indeed he possessed the artistic temperament in a high degree. As a youth he was urged to make painting his profession. In early years he drew thousands of illustrations of insects, which were characterized as much by beauty and delicacy of line as by minute accuracy. In later and busier times his taste for form and color were chiefly gratified in his favorite recreation of gardening. He was a most accomplished horticulturist, and his garden on Washington Heights was the best kept and most beautiful in the city, and gave evidence of the control of a master mind.

Riley was a thorough American in habits of thought and in sympathy, yet he often visited the little village of Walton, on the banks of the Thames, where he had passed the earlier years of his life. In these visits he learned something of his forefathers. His peculiar Southern features, his warm complexion, his dark eyes and hair, which made many people suppose him to be a Spaniard or an Italian, were derived from a more northern Celtic race, his ancestors, whose history he succeeded in tracing for many generations, having migrated from Wales to England at quite a recent day.

His schoolboy days were passed in France and Germany, and he was but seventeen when his restless spirit led him America.

"He went West and settled with Mr. G. H. Edwards, whom he had met in London and who had made arrangements to open a stock farm in Kankakee county, Illinois. Here, during three years, he acquired that experience of Western agriculture that can be gained only by actual farm work. Fond of all life as manifested on the farm, young Riley devoted himself enthusiastically to the calling he had chosen.

Of an inquiring and experimental turn of mind, he aimed to improve on the methods in vogue, and soon won the esteem of all who knew him ; and, though so young, was sought for in counsel and honored at public gatherings, at which he became intimate with Emory Cobb and other prominent farmers of Illinois. Under these circumstances, and with a deep love of nature in all her manifestations, it is no wonder that Professor Riley, as we have heard him avow, looks back to the farming days in Illinois as the happiest of his life.

"The experience gained on the farm has enabled him, more than anything else, to understand the position and needs of the farmer. In writing of Prof. Riley's farm life and the reasons why he abandoned it, a Kankakee friend who knew him well, remarks: 'Young Riley was simply too enthusiastic and too bent on excelling in everything. He took no rest. Often he would be up, actually get breakfast ready to relieve the womenfolk, and milk half a dozen cows before the others were about. When others were resting at noon in the shade, he would be working at his flowers under a July sun. There was not a sick animal of the three hundred on the place that he did not understand and help. He kept a lot of bees, got hold of the best bred colts and some of the best heifers in the county, secured a good quarter section, and spent his Sundays reading, sketching, and studying insects. Three years of this increasing effort under the trying climatic extremes of central Illinois broke the young fellow's health, for it was a great contrast to his previous life, and with every one telling him that he was wasting his talent he finally concluded to give up the idea of farming. But had his health not failed him, my opinion is that he would be a farmer to-day, and a successful one too, for he has intense love of rural life.'

"He went to Chicago in his twentieth year, with no definite trade or profession and with little experience of city life. Money was scarce among farmers in those days, and his little property was so invested that it was not available. The trials of his first few months in Chicago are familiar to only a few of his intimate friends, but the manner in which he overcame them while yet in but poor health was characteristic. Pride prevented him from asking help from his Kankakee friends, but did not prevent him from donning blue overalls and doing manual labor in a pork-packing establishment, or from adding to his slender income by making portraits of fellow-boarders, or sketches which he himself disposed of at evening in the abodes of wealth on Michigan avenue. After a while he obtained an engagement as reporter on the *Evening Journal*, but finally became connected with the *Prairie Farmer*, then the leading agricultural paper of the West. Besides a close application to the duties of his position as reporter, delineator and editor of the entomological department of this paper, he devoted his time and energies to the study of botany and entomology. His industry and versatility soon made him not only popular with his associates upon the paper, but gave him a widespread reputation as a writer upon natural history, especially on his specialty of economic entomology, the importance of which he soon made apparent." *

His adventurous temperament led him to enlist as a private in the 134th Illinois Volunteers, in which he served for several months during the Civil War in Kentucky and Tennessee.

Before entering the army he had made the acquaintance of the man whom he joined in 1868 in establishing the *American Entomologist*. This friend, who was senior editor until his death, was Dr. Benjamin D. Walsh, State Entomologist of Illinois, and it was Walsh to whom Riley always alluded as his master and the man to whom he was most indebted for his early training and inspiration. Mr. Walsh was a graduate of the University of Cambridge, in the class with Darwin, a man of great and scholarly attainments and a most careful and painstaking investigator. During the few years of his residence in Illinois he had done much to develop the interest in economic entomology, which resulted in the establishment of the position of State Entomologist of Missouri in 1868, which was the beginning of Riley's public labors.

An important outgrowth of Riley's personal activity in connection with his official work was the formation of the Riley Collection of insects, upon which he began immediately after he left the army in 1864, and which at the end of twenty-five years included over 20,000 species, and over 115,000 mounted specimens, besides much other material. The collection is in many respects unique, especially so because of the complete manner in which the life-history

*Colman's *Rural World*, St. Louis, May 12, 1892.

of numerous individual species is represented. It is the legitimate outgrowth and complement of Riley's investigations, and is a voucher for the accuracy and fulness of his personal work in entomology. This collection he gave in 1882, without condition, to the National Museum, at that time without a collection of insects. His purpose in doing this was to place in the Museum a worthy nucleus, and to be instrumental in the formation of a collection which would be worthy of the Nation. He was appointed at once honorary curator of the department of insects in the Museum, and gave much attention to the department, which thereafter made rapid advances.

Professor Riley's first interest in the study of insects was from this standpoint of a field naturalist. He did little in systematic entomology; the species which he described were but few, and he was quite content to leave monographic and critical work to others. His tastes led him to study the life histories, to trace each form through all its transformations, to know its habits, its food and its manner of life; and to understand its relations to, and its influence upon, the plants among which it lives and upon which it feeds. To the fact that he knew thoroughly the life histories of so many insects was due the importance of his contributions to economic entomology; but he was by no means content, as I have said, with the results in this field, although his deep interest in agriculture and horticulture led inevitably to practical conclusions with regard to every species which he studied. His writings are full of important and original observations in pure biology, and constitute a mine of reference for zoölogists and botanists, especially those studying the subject of transformism or evolution. He was indeed one of the earliest American transformists. He published an early and appreciative notice of Darwin's work, and I have seen many letters addressed to him by Darwin. He was also the correspondent and friend of Alfred Russell Wallace, Herbert Spencer, Henry Bates and of other eminent workers in kindred fields.

His writings abound in decisions of the greatest interest to students of evolution. His papers on 'The Caprification of the Fig,' on 'The Yucca Moth and Yucca Pollination' and on 'Some Interrelations of Plants and Insects' were especially interesting.

The most important of his philosophic papers was his address on 'The Cause of Variations in Organic Forms,' which he delivered when Vice-President of the American Association for the Advancement of Science, in 1888.

Passing allusion may be made to his interest in other branches of science. He had great interest in mechanical devices of all kinds, and in 1869 read before the French Academy of Sciences a paper on 'The Perfecting of the Graphophone,' which was regarded in France as suggestive and original. His studies of the flight of insects led him to take great interest in the problem of artificial flight; and his own skill as a prestidigitator, in which he took great delight, induced him to give much attention to spiritualism, in which he was no believer, but which attracted him on account of his own success in exposing frauds. During the last visit to Washington of Alfred Russell Wallace, who was a believer in spiritualism, he succeeded in proving impositions on the part of certain mediums whom the English philosopher was disposed to trust.

His standing as a naturalist was so high that three years ago, when the Hope professorship of entomology in the University of Oxford became vacant through the death of Professor Westwood, he was one of the two most prominent candidates for this position and failed of election by only a few votes. Indeed, it was known to have

been Professor Westwood's own wish that Riley should be his successor.

He was greatly interested in the establishment of an insectary, in connection with the Smithsonian Institution, where, in connection with his museum work, he might carry out still further his investigation into the life history of members of his favorite group.

It was as an economic entomologist that Riley was most widely famed. In this field he was eminent in two respects—in administration, as well as in his direct contributions to the science of practical entomology, and to the art which is its outgrowth.

As an administrator, he was associated with three prominent undertakings: the entomological work of the State of Missouri, the United States Entomological Commission, and the establishment of the division of entomology of the Department of Agriculture.

He held the position of entomologist to the State of Missouri for nearly ten years, entering upon this work at the age of twenty-three. Concerning what he accomplished and how he did it, I shall allow one more competent than myself to speak:

"In the spring of 1868 his writings upon injurious insects brought about his appointment to the newly created office of entomologist to the State of Missouri, and from that time until 1877 he was engaged in the investigation which thoroughly established his fame. During that period he published nine annual reports, which have become classics in entomological literature. At the time when his work was begun, the science of practical entomology was in its infancy. The writings of Harris and Fitch had resulted in the tracing of the life-history of many of the principal injurious insects, but the recommendations as to the remedies were more or less crude, many important points were left uninvestigated, even with the commonest crop enemies, and a few entirely erroneous conclusions had been reached. Beyond the work of these two men, practically nothing had been done except the first report of Benjamin D. Walsh, which had just appeared.

"Looking back over Professor Riley's work during these years, one cannot help being amazed at its extent and character, especially when one considers that he worked single-handed, had many obstacles to overcome, and great demands upon his time in the way of correspondence, lectures and addresses. Every insect which he took up (and he published upon an immense number, including all that were then of great importance) was treated from a standpoint of absolute originality. The statements were based upon actual field observation, and the remedies proposed were the results of experiment or deductions from a perfect knowledge of the insects' habits and life history. In fact, it is no exaggeration to say that the modern science of economic entomology is based upon and dates from the publication of these reports.

"The original edition of these reports has long since been exhausted, but they are still continually sought for and command high prices. They are replete with the results of original research, and their illustrations created an epoch in the science no less than their text. The reports of the State Board of Agriculture containing them have long been sought by book dealers, who detach the entomological portions and sell the rest to junk dealers.

"Of these Missouri reports the late Charles Darwin wrote that they contained a vast number of facts and generalizations valuable to him, and that he was struck with admiration at the author's powers of observation."*

The United States Entomological Commission was in existence for five years, Riley having having been its chief from the beginning.

"We all remember," said the *Pacific Rural Press* in 1887, "the sad experiences which our Western States and Territories passed through from 1873 to 1877, from locust or grasshopper ravages, which resulted in destitution and precipitated a financial crisis. These ravages seriously affected the western portion of his own State, and Prof. Riley took hold of the problem with that originality and vigor which have characterized all of his work. His last three reports to the State contain the first positive and accurate knowledge on the subject that has been published. But he early saw that the subject was one of National importance, and could not be fully dealt with by work

* L. O. Howard, A Distinguished Entomologist, *The Farmers' Magazine*, London, I., 23, F.

in any one State. To feel a necessity was sufficient for him to act, and consequently we find him in public lectures, in leading articles, through resolutions offered at societies' meetings, memorials to Congress, and in every other way urging the creation of a National Entomological Commission. After various bills had been introduced and discussed, Congress finally created the Entomological Commission, with a special view to investigate the Rocky Mountain locust, or so-called grasshopper, and Prof. Riley was tendered the position as Chief of the Commission, a distinction which his investigations into this insect had justly earned, for he had already not only made most important discoveries as to its habits and the best means of subduing it, but had ascertained sundry laws that govern it, so as to be able to predict the time of its coming and going and the limits of its spread. Consulted by Secretary Schurz as to the other appointments, it is no wonder that the members chosen were Doctor A. S. Packard, Jr., a naturalist of eminence, one of the first entomologists of the world, and a prominent author and editor, and Prof. Cyrus Thomas, who had likewise labored for the creation of the Commission and who was the authority on the family of insects to which the locusts belonged. Both of these gentlemen, like Prof. Riley, had been chosen by their respective States as official entomologists, and had a large personal experience in the West. Accepting charge of the Commission thus constituted in March, 1877, we find Riley travelling that year over most of the Western country, from the Gulf to the South Saskatchawan, in British America, now in company with the Governor of the State, and again with other special officials, but everywhere exhorting the farmers to action, making careful observations and experiments, and inspiring confidence."

The work of the Commission was carried on with all the originality and vigor which characterized his work, and its annual reports contain a mass of important results, embodying the first real and definite knowledge on the subject which had seen the light of print. One of his associates writes:

"It was mainly owing to his executive ability, business sagacity, experience in official life, together with the scientific knowledge and practical inventive turn of mind in devising remedies, or selecting those invented by others, that the work of the Commission was so popular and successful during the last five years of its existence."*

The publications of the Commission consisted of five illustrated reports and seven bulletins. Of the former, Riley, himself, wrote that "the five taken together represent an amount of original investigation and experiment, the practical outcome of which has certainly never been excelled in the annals of economic entomology." In these reports were discussed not only the Rocky Mountain locust and its allies, but the cotton worm, the Boll worm, the army worm, the cankerworms and insects injurious to forest trees.

The position of of United States Entomologist was held by him during fourteen years, or from 1878, with a brief intermission, until nearly the time of his death; and during the period of his incumbency the Division of Entomology was organized. His successor in this position wrote in 1890:

"The present efficient organization of the Division of Entomology was his own original conception, and he is responsible for its plan down to the smallest detail. It is unquestionably the foremost organization of its kind at present in existence. It has a small permanent corps of scientific workers, who have been trained under him and who assist in the preparation and editing of reports, in the care of insects, the life-histories of which are being studied, in the making of elaborate notes, in the mounting and arranging of specimens for permanent economic and classificatory collections, in making drawings for illustrations to the reports and in the very large correspondence. The training of these assistants and their present efficiency and standing in the scientific world is only another

*A. S. Packard, SCIENCE, N. S., II., 74, F.

instance of the thoroughness of Prof. Riley's methods. Several of them have gone out from this office to accept important positions under the State governments, and thus the influence of his training has become widespread.'"*

His achievements in the art of practical entomology were many, but these were they which have been recognized as of especial and permanent value.

He was the first to demonstrate the practicability of checking the ravages of an imported species of insect by enlisting the aid of the insect enemies which had kept it in check in its native habitat. This was effected by the introduction from Australia, in 1888, at his instance and by two agents sent out from his office, of the Australian *Vedalia*—a species of lady-bird, which is the natural enemy of the 'Fluted Scale' an insect which had found its way from Southern Australia to California, and was fast destroying the orange and lemon groves.

His studies in connection with *Phylloxera*, the French vine pest, although not more important than many others more purely American in interest, may well be referred to on account of the attention which they attracted in France and honors conferred upon him as a result. To him is generally attributed the idea of reviving etiolated French vineyards by using certain American phylloxera-proof stocks to graft upon. In a sketch recently published by Monsieur Valery Mayet, in the *Revue de Viticulture*, certain statements are made which I quote:

"This notice being written especially for grape culturists, especial mention should be made of Riley's work upon insects destructive to the grape vine.

"From 1866 to 1884, during which time Riley made numerous visits to France, there appeared a constant succession of notes and articles upon insects inimical to the vine, and especially upon *Phylloxera*. Riley was, most certainly, one of the very earliest investigators on this subject, and long before he discussed the insect in Europe, he published in the *Prairie Farmer*, of August 3, 1866, a description of the insect, the first good description, since as he remarks, 'It had before been described only very briefly by Dr. Fitch, in New York, in 1856, under the name of *Pemphigus vitifolii*.'

"As soon as the *Phylloxera* had been discovered in France; in 1868 Riley began a correspondence with the three naturalists who were especially interested in this insect, J. E. Planchon, Lichtenstein and Signoret. He even visited France in this connection. The first idea suggested to his mind was to compare the American species with that of Europe. 'Lichtenstein and I' wrote Planchon in 1865, 'had the idea that the *Pemphigus vitifolii* of Fitch was nothing but our *Phylloxera vastatrix*. This theory was confirmed as soon as Riley, coming for that express purpose to Europe, assured us of the identity of the insects of the two countries.' Riley, on the other hand, had remarked, in 1871:

"'The observations made by me in America and Europe, of the winged and wingless forms, leaves no doubt in my mind that the insects of the two continents are identical.'

"The successive notices published by Riley, from 1868 to 1880, upon the insect, which for a long period of time prevented the culture of the European vine in the United States, a series of notes, not less than fifty-five in number, demonstrated the important connection of this naturalist with this very important question. His name soon became as popular in America as that of Planchon in France."*

As long ago as 1873 the vine-growers of France presented him with a gold medal, struck in recognition of his investigations into the history of the Phylloxera. In 1889, as a further proof of their appreciation of his services, they presented to him a beautiful statue in bronze, while the French government conferred upon him the Cross of the Legion of Honor.

Associated prominently with his name are certain practical methods for the destruction of insects, the use of kerosene emulsions to protect plants and trees from the attacks of suctorial insects, and the invention and perfection, aided by Mr. W. S. Barnard, of a very ingenious series of mechanical devices for spraying insecticides and fungicides in a liquid form, often called the Riley system.

* Howard, *loc. cit.*

* Revue de Viticulture.

It may perhaps be unwise to ignore the fact that the credit of certain of Riley's achievements has been claimed by others, in some instances by those who were first to call attention to facts out of which these achievements have grown, in other instances by those who were employed by Professor Riley to carry his ideas into effect.

It would be fruitless to enter into the consideration of any of these claims. Some of the claimants are perhaps entitled to a larger share of credit than has been given them in the official publications in which the results of their work are discussed. It is doubtful, however, whether in any instance any other would have succeeded so soon, or so completely as did Riley. His, in every instance, was the directing mind. It was he who chose the man through whose agency the work was accomplished. It was the mind of Riley which directed, and the will of Riley which controlled, the activities of his agents. It is my honest conviction that in most instances the agents would neither have begun the work under other circumstances, or completed it, except under such control, and that he was able to have done the work unaided, the results of his first years' efforts, when he was laboring single-handed, fully demonstrate.

There cannot well be better evidence of the eminence of the man and the value of his work than the testimony of the numerous journals in their comments upon his death, and especially the journals which are devoted to ecomonic methods rather than those of the professional men of science.

The *Canadian Entomologist*, London, Ontario, said:

"As an economic entomologist, taking him for all in all, he was the most eminent the world has ever seen."*

Natural Science, London,† called him 'the prince of economic entomologists,' and says of his reports that they are "characterized by scientific accuracy coupled with clear and popular exposition, and while of special value to the farmer, fruit grower and forester, they abound with observations of interest to the pure naturalist."

Psyche, Cambridge, said:

"In his death America loses not only its best known entomologist, but one who by his ability, sagacity, example and the line his studies have taken, has done more for the advancement of our special science than any one America has ever reared." *

The editor of *The Farmers' Magazine*, of London, wrote:

"His studies of Hessian-fly and the Hop-fly, in England, have a direct bearing upon our agricultural prosperity, and his election as an honorary member of the Royal Agricultural Society, and still more recently as an Honorary Fellow of the Entomological Society of London, testify to the esteem in which he he is held, not only by our representatives of advanced agriculture, but also by those engaged here in investigations in the field of pure entomology." †

R. McLachlan, F. R. S., in the *Entomologists' Monthly Magazine*, London, said:

"The Missouri Reports proved the thoroughness of his work, his originality in divising mechanical means for distributing the remedial agents he adopted and his great skill as an artist. These Reports drew forth the highest encomiums all over the world. * * * Riley was nothing if not original. There was probably only one real *fiasco* in his career. The rapid spread of the Colorado Beetle induced him to predict its speedy appearance on this side of the Atlantic. The Colorado Beetle disappointed him by not acting up to his anticipations."‡

W. Fream, writing in the Journal of the Royal Agricultural Society of England, spoke of him as "the greatest agricultural entomologist of our age," and said:

"In him a striking presence was associated with a versatile genius. Naturalist, linguist, artist, soldier, he was withal a delightful companion, a sincere friend. In that branch of study which he made peculiarly his own he has established an ideal which few

* *Canadian Entomologist*, October, 1895, 273.

† *Natural Science*, November, 1895, 360.

* *Psyche*, November, 1895, p. 308.

† *The Farmers' Magazine*, I., 221.

‡ *Entomologists' Monthly Magazine*, No. 378, November, 1895, 269.

can hope to approach and none to excel. Taken from our midst in the early prime of life, it can nevertheless, with all truth, be said that in the voluminous records of his incessant work he has indeed left behind him *monumentum aere perennius.*"

G. BROWN GOODE.

SCIENTIFIC MATERIALISM.

AT the meeting of the Naturforscher-Versammlung, held last September, at Lübeck, Germany, Professor W. Ostwald, of Leipzig, delivered an address which was received with great interest, and gave rise to much discussion. The address has since been published in the *Zeitschrift für Physikalische Chemie* (Volume XVIII., p. 305), under the title 'Die Ueberwindung des wissenschaftlichen Materialismus,' and it seems desirable to call attention to it in this place, as it is highly suggestive, and its careful study is likely to be of benefit. The following is in the main a free translation of the more important parts of the address:

There is one point upon which scientific men agree, and that is that all things consist of moving atoms, and that these atoms and the forces acting upon them are the final realities. According to this, a natural phenomenon is explained when the exact nature of the motion of the atoms of the substance exhibiting the phenomenon is known. There is nothing beyond this. Matter and motion are ultimate conceptions. This is *scientific materialism*. The author believes that this view is untenable. It must be given up and a better view substituted for it. He states particularly that what he has to say has, at present, nothing to do with ethical and religious conceptions.

In investigating natural phenomena we first *register* and *classify*. From *registration* we reach the *system*; from this the *law of nature*, the most comprehensive form of which is the *general conception*. The most important element in the law is the *invariant*, a quantity that remains unchanged whatever changes may take place. Such an invariant is *mass*. This did not at first appear broad enough, and thus the conception of *matter* came to light, and the *physical law* of the *conservation of mass* was transformed into the *metaphysical axiom* of the *conservation of matter*. By this step a number of hypothetical elements are introduced into the conception that was originally free from hypothesis. It is now held that when, for example, iron and oxygen combine, the two forms of matter are in the compound, only they have new properties. This the author considers nonsense, for all that we know in regard to a certain stuff is that it has certain properties.

Galileo introduced the conception of the constant working *force* and thus explained the phenomenon of falling bodies. Newton assumed the same force as acting between the heavenly bodies and governing their motions. These great successes led to the conviction that all physical phenomena might be explained in the same way. Thus arose the *mechanical conception* of nature. It is not generally noticed to what an extent this conception is hypothetical, indeed metaphysical. On the other hand, it must be noted that this mechanical conception of heat, electricity, magnetism, chemism, has not been confirmed in a single case. It has not been possible to express the relations by a corresponding mechanical system, so that nothing is left unaccounted for.

The history of optics furnishes an excellent example. As long as optics included only the phenomena of reflection and refraction, the mechanical conception of Newton was satisfactory, according to which light consists of small particles sent out in straight lines. When later the phenomena of interference and polarization came to be studied, it was found that Newton's mechanical conception could not explain them, and the vibration theory of Huygens and Euler was adopted. But it was then necessary to imagine some medium

which could transmit the vibrations, and thus the hypothetical ether took its place in the scientific mind. The phenomena of polarization require that the vibrations shall be transverse, and therefore the ether must be a solid. The calculations of Lord Kelvin have shown that a medium with properties, such as must be ascribed to the ether to account for the facts known, would not be stable, in other words, that it could not exist. Probably in order to save the electro-magnetic theory from a like fate, the immortal Herz, to whom this theory owes so much, expressly declines to see anything in it but a system of six differential equations.

The task of science is to find the relations that exist between realities, measurable quantities, so that when some are known others can be deduced. This idea is not new. Mayer, fifty-three years ago, discovered the equivalence of the natural forces, or, as we say to-day, of the different forms of energy. Then Clausius, Helmholtz and W. Thompson thought it necessary to interpret the law of the equivalence of the different forms of energy by assuming that all the different forms of energy are fundamentally the same, that is to say, *mechanical energy*. This was distinctly a backward step.

How is it then possible, by means of such an abstract idea as energy, to form a conception of the universe, which in clearness can be compared with the mechanical? What do we then know of the physical world? Plainly only that which comes to us through our sensory organs. What conditions must be satisfied in order that one of these organs shall be affected? We may turn the matter in any way we please, we find no common feature but this: The sensory organs are affected by energy changes between them and their environment. In a world, the temperature of which is everywhere the same as that of our bodies, we could not know anything of heat, just as we do not feel the constant atmospheric pressure under which we live. Only when we produce spaces with other pressures do we gain any knowledge of it.

It is often said energy is imaginary, while matter is the reality! The author answers: On the contrary, matter is a product of the imagination, that we have constructed very imperfectly in order to represent the permanent in the everlasting changes.

According to the author, matter and energy are not to be thought of as distinct, as for example, body and soul. If we attempt to think of matter as separate from the various forms of energy nothing is left. Matter is, in fact, nothing but a group of different energies arranged in space. He then makes use of this crude illustration. Imagine yourself struck with a cane. What do you feel, the cane or its energy? Of course, it is the energy. The cane at rest is harmless.

Everything that has hitherto been represented by the aid of the conceptions of force and matter, and much more, can be represented by means of the conception of energy. We make a great gain by indulging in no hypotheses in regard to the connection between the different forms of energy except that which is specified in the law of conservation, and we gain the freedom of studying the different phenomena objectively.

Finally, it may be asked, is energy the last reality? However, necessary and useful for the understanding of nature energy may be, is there nothing beyond it? Or are there phenomena which cannot be fully expressed by the now known law of energy? The author expresses the belief that energy is not sufficient to enable us to deal with all nature. It will probably appear in the future as a special case of still more general relations of the form of which we have at present no conception.

In a later number of the *Zeitschrift für physikalische Chemie*, Ostwald reviews the second edition of J. B. Stallo's 'The Concepts and Theories of Modern Physics' that appeared in 1885, and expresses the hope that the book may find half as many readers as it deserves. The book was first issued in 1882 as one of the *International Scientific Series*, and scientific men as a whole regarded it unfavorably, though some of them certainly recognized the force of many of the author's arguments against the materialistic conceptions which were then and are now generally held.

IRA REMSEN.

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*ON A NEW KIND OF RAYS.**

1. A DISCHARGE from a large induction coil is passed through a Hittorf's vacuum tube, or through a well-exhausted Crookes' or Lenard's tube. The tube is surrounded by a fairly close-fitting shield of black paper; it is then possible to see, in a completely darkened room, that paper covered on one side with barium platinocyanide lights up with brilliant fluorescence when brought into the neighborhood of the tube, whether the painted side or the other be turned towards the tube. The fluorescence is still visible at two metres distance. It is easy to show that the origin of the fluorescence lies within the vacuum tube.

2. It is seen, therefore, that some agent is capable of penetrating black cardboard which is quite opaque to ultra-violet light, sunlight or arc-light. It is therefore of interest to investigate how far other bodies can be penetrated by the same agent. It is readily shown that all bodies possess this same transparency, but in very varying degrees. For example, paper is very transparent; the fluorescent screen will light up when placed behind a book of a thousand pages; printer's ink offers no marked resistence. Similarly the fluorescence shows behind two packs of cards; a single card does not visibly diminish the brilliancy of the light. So, again, a single thickness of tinfoil hardly casts a shadow on the screen; several have to be superposed to produce a marked effect. Thick blocks of wood are still transparent. Boards of pine two or three centimetres thick absorb only very little. A piece of sheet aluminium, 15 mm. thick, still allowed the X-rays (as I will call the rays, for the sake of brevity) to pass, but greatly reduced the fluorescence. Glass plates of similar thickness behave similarly; lead glass is, however, much more opaque than glass free from lead. Ebonite several centimetres thick is transparent. If the hand be held before the fluorescent screen, the shadow shows the bones darkly, with only faint outlines of the surrounding tissues.

Water and several other fluids are very transparent. Hydrogen is not markedly more permeable than air. Plates of copper, silver, lead, gold and platinum also allow the rays to pass, but only when the metal is thin. Platinum .2 mm. thick allows some rays to pass; silver and copper are more transparent. Lead 1.5 mm. thick is practically opaque. If a square rod of wood 20 mm. in the side be painted on one face with white lead it casts little shadow when it is so turned that the painted face is parallell to the X-rays, but a strong shadow if the rays have to pass through the painted side. The salts of the metal, either solid or in solution, behave generally as the metals themselves.

3. The preceding experiments lead to the conclusion that the density of the bodies is the property whose variation mainly affects their permeability. At least no other property seems so marked in this connection. But that the density alone does not determine the transparency is shown by

* From the translation in *Nature* by Arthur Stanton from the *Sitzungsberichte der Würzburger Physik-medic. Gesellschaft*, 1895.

an experiment wherein plates of similar thickness of Iceland spar, glass, aluminium and quartz were employed as screens. Then the Iceland spar showed itself much less transparent than the other bodies, though of approximately the same density. I have not remarked any strong fluorescence of Iceland spar compared with glass (see below, No. 4).

4. Increasing thickness increases the hindrance offered to the rays by all bodies. A picture has been impressed on a photographic plate of a number of superposed layers of tinfoil, like steps, presenting thus a regularly increasing thickness. This is to be submitted to photometric processes when a suitable instrument is available.

5. Pieces of platinum, lead, zinc, and aluminium foil were so arranged as to produce the same weakening of the effect. The annexed table shows the relative thickness and density of the equivalent sheets of metal.

	Thickness.	Relative thickness.	Density.
Platinum.....	·018 mm.	1	21·5
Lead.....	·050 "	3	11·3
Zinc	·100 "	6	7·1
Aluminium....	3·500 "	200	2·6

From these values it is clear that in no case can we obtain the transparency of a body from the product of its density and thickness. The transparency increases much more rapidly than the product decreases.

6. The fluorescence of barium platinocyanide is not the only noticeable action of the X-rays. It is to be observed that other bodies exhibit fluorescence, *e. g.* calcium sulphide, uranium glass, Iceland spar, rock salt, &c.

Of special interest in this connection is the fact that photographic dry plates are sensitive to the X-rays. It is thus possible to exhibit the phenomena so as to exclude the danger of error. I have thus confirmed many observations originally made by eye observation with the fluorescent screen. Here the power of the X-rays to pass through wood or cardboard becomes useful. The photographic plate can be exposed to the action without removal of the shutter of the dark slide or other protecting case, so that the experiment need not be conducted in darkness. Manifestly, unexposed plates must not be left in their box near the vacuum tube.

It seems now questionable whether the impression on the plate is a direct effect of the X-rays, or a secondary result induced by the fluorescence of the material of the plate. Films can receive the impression as well as ordinarly dry plates.

I have not been able to show experimentally that the X-rays give rise to any calorific effects. These, however, may be assumed, for the phenomena of fluorescence show that the X-rays are capable of transformation. It is also certain that all the X-rays falling on a body do not leave it as such.

The retina of the eye is quite insensitive to these rays; the eye placed close to the apparatus sees nothing. It is clear from the experiments that this is not due to want of permeability on the part of the structures of the eye.

7. After my experiments on the transparency of increasing thicknesses of different media, I proceeded to investigate whether the X-rays could be deflected by a prism. Investigations with water and carbon bisulphide in mica prisms of 30° showed no deviation either on the photographic or the fluorescent plate. For comparison, light rays were allowed to fall on the prism as the apparatus was set up for the experiment. They were deviated 10 mm. and 20 mm. respectively in the case of the two prisms.

With prisms of ebonite and aluminium I have obtained images on the photographic plate which point to a possible deviation. It is, however, uncertain, and at most would

point to a refractive index 1.05. No deviation can be observed by means of the fluorescent screen. Investigations with the heavier metals have not as yet led to any result, because of their small transparency and the consequent enfeebling of the transmitted rays.

On account of the importance of the question it is desirable to try in other ways whether the X-rays are susceptible of refraction. Finely-powdered bodies allow in thick layers but little of the incident light to pass through, in consequence of refraction and reflection. In the case of the X-rays, however, such layers of powder are for equal masses of substance equally transparent with the coherent solid itself. Hence we cannot conclude any regular reflection or refraction of the X-rays. The research was conducted by the aid of finely-powdered rock salt, fine electrolytic silver powder, and zinc dust, already many times employed in chemical work. In all these cases the result, whether by the fluorescent screen or the photographic method, indicated no difference in transparency between the powder and the coherent solid.

It is, hence, obvious that lenses cannot be looked upon as capable of concentrating the X-rays; in effect, both an ebonite and a glass lens of large size prove to be without action. The shadow photograph of a round rod is darker in the middle than at the edge; the image of a cylinder filled with a body more transparent than its walls exhibits the middle brighter than the edge.

8. The preceding experiments, and others which I pass over, point to the rays being incapable of regular reflection. It is, however, well to detail an observation which at first sight seemed to lead to an opposite conclusion.

I exposed a plate, protected by a black paper sheath, to the X-rays, so that the glass side lay next to the vacuum tube. The sensitive film was partly covered with star-shaped pieces of platinum, lead, zinc and aluminium. On the developed negative the star-shaped impression showed dark under platinum, lead, and, more markedly, under zinc; the aluminium gave no image. It seems, therefore, that these three metals can reflect the X-rays; as, however, another explanation is possible, I repeated the experiment with this only difference, that a film of thin aluminium foil was interposed between the sensitive film and the metal stars. Such an aluminium plate is opaque to ultra-violet rays, but transparent to X-rays. In the result the images appeared as before, this pointing still to the existence of reflection at metal surfaces.

If one considers this observation in connection with others, namely, on the transparency of powders, and on the state of the surface not being effective in altering the passage of the X-rays through a body, it leads to the probable conclusion that regular reflection does not exist, but that bodies behave to the X-rays as turbid media to light.

Since I have obtained no evidence of refraction at the surface of different media, it seems probable that the X-rays move with the same velocity in all bodies, and in a medium which penetrates everything, and in which the molecules of bodies are embedded. The molecules obstruct the X-rays the more effectively as the density of the body concerned is greater.

9. It seemed possible that the geometrical arrangement of the molecules might affect the action of a body upon the X-rays, so that, for example, Iceland spar might exhibit different phenomena according to the relation of the surface of the plate to the axis of the crystal. Experiments with quartz and Iceland spar on this point lead to a negative result.

10. It is known that Lenard in his investigations on cathode rays has shown that they belong to the ether and can pass

through all bodies. Concerning the X-rays the same may be said.

In his latest work Lenard has investigated the absorption coefficients of various bodies for the cathode rays, including air at atmospheric pressure, which gives 4.10, 3.40, 3.10 for 1 cm., according to the degree of exhaustion of the gas in discharge tube. To judge from nature of the discharge, I have worked at about the same pressure, but occasionally at greater or smaller pressures. I find using a Weber's photometer that the intensity of the fluorescent light varies nearly as the inverse square of the distance between screen and discharge tube. This result is obtained from three very consistent sets of observations at distances of 100 and 200 mm.; hence air absorbs the X-rays much less than the cathode rays. This result is in complete agreement with the previously described result, that the fluorescence of the screen can be still observed at 2 metres from the vacuum tube. In general other bodies behave like air; they are more transparent for the X-rays than for the cathode rays.

11. A further distinction, and a noteworthy one, results from the action of a magnet. I have not succeeded in observing any deviation of the X-rays even in very strong magnetic fields.

The deviation of cathode rays by the magnet is one of their peculiar characteristics; it has been observed by Hertz and Lenard that several kinds of cathode rays exist, which differ by their power of exciting phosphorescence, their susceptibility of absorption and their deviation by the magnet; but a notable deviation has been observed in all cases which have yet been investigated, and I think that such deviation affords a characteristic not to be set aside lightly.

12. As the result of many researches, it appears that the place of most brilliant phosphorescence of the walls of the discharge tube is the chief seat whence the X-rays originate and spread in all directions; that is, the X-rays proceed from the front where cathode rays strike the glass. If one deviates the cathode rays within the tube by means of a magnet, it is seen that the X-rays proceed from a new point, *i. e.*, again from the end of the cathode rays.

Also for this reason the X-rays which are not deflected by a magnet cannot be regarded as cathode rays which have passed through the glass, for that passage cannot, according to Lenard, be the cause of the different deflection of the X-rays. Hence, I concluded that the rays are not identical with the cathode rays, but are produced from the cathode rays at the glass surface of the tube.

13. The rays are generated not only in glass. I have obtained them in an apparatus closed by an aluminium plate 2 mm. thick. I propose later to investigate the behavior of other substances.

14. The justification of the term 'rays,' applied to the phenomena, lies partly in the regular shadow pictures produced by the interposition of a more or less permeable body between the source and a photographic plate or fluorescent screen.

I have observed and photographed many such shadow pictures. Thus, I have an outline of part of a door covered with lead paint; the image was produced by placing the discharge tube on one side of the door, and the sensitive plate on the other. I have also a shadow of the bones of the hand (Fig. 1); of a wire wound upon a bobbin; of a set of weights in a box, of a compass card and needle completely enclosed in a metal case; of a piece of metal where the X-rays show the want of homogeneity, and of other things.

For the rectilinear propagation of the rays I have a pin-hole photograph of the discharge apparatus covered with black paper. It is faint, but unmistakable.

15. I have sought for interference effects of the X-rays, but possibly, in consequence of their small intensity, without result.

FIG. 1.—Photograph of the bones in the fingers of a living human hand. The third finger has a ring upon it.

16. Researches to investigate whether electrostatic forces act on the X-rays are begun, but not yet concluded.

17. If one asks, what then are these X-rays; since they are not cathode rays, one might suppose, from their power of exciting flourescence and chemical action, them to be due to ultra-violet light. In opposition to this view a weighty set of considerations presents itself. If X-rays be indeed ultra-violet light, then that light must possess the folling properties.

(*a*) It is not refracted in passing from air into water, carbon bisulphide, aluminium, rock salt, glass or zinc.

(*b*) It is incapable of regular reflection at the surfaces of the above bodies.

(*c*) It cannot be polarized by any ordinary polarizing media.

(*d*) The absorption by various bodies must depend chiefly on their density.

That is to say, these ultra-violet rays must behave quite differently from the visible, infra-red, and hitherto known ultra-violet rays.

These things appear so unlikely that I have sought for another hypothesis.

A kind of relationship between the new rays and light rays appears to exist; at least the formation of shadows, fluorescence, and the production of chemical action point in this direction. Now it has been known for a long time that, besides the transverse vibrations which account for the phenomena of light, it is possible that longitudinal vibrations should exist in the ether, and according to the view of some physicists must exist. It is granted that their existence has not yet been made clear, and their properties are not experimentally demonstrated. Should not the new rays be ascribed to longitudinal waves in the ether?

I must confess that I have in the course of this research made myself more and more familiar with this thought, and venture to put the opinion forward, while I am quite conscious that the hypothesis advanced still requires a more solid foundation.

W. C. RÖNTGEN.

RÖNTGEN RAYS.

PROFESSOR RÖNTGEN'S discovery brings to a close a most interesting chapter in the history of electricity; it is the chapter dealing with electric discharges through rarefied gases. Experiments on electric discharges through vacua have for quite a long period now attracted the attention of physicists. Elaborate accounts of these experiments can be found in the transactions of learned societies throughout the last century. A systematic research into the various phenomena accompanying vacuum discharges dates from the time of Faraday. Plücker, Hittorf and Goldstein in Germany, and Spottiswoode and Crookes in England, may be mentioned as the foremost

investigators who extended very much what Faraday had only commenced. Among the numerous, most interesting, and indeed remarkable, results obtained by these investigators, the behavior of the discharge, which under certain conditions, emanates from the negative electrode, the so-called cathode, was always considered as the most remarkable.

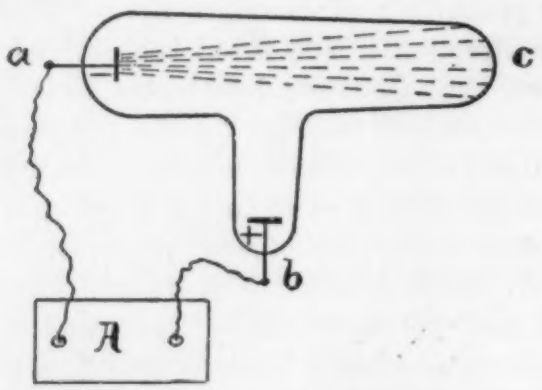


Fig. I. represents a typical form of the vacuum tube capable of showing a strongly developed cathode discharge. At *a* we have one electrode and at *b* the other. They consist of platinum discs attached to platinum wires which are sealed in the glass. Let the electrode *a* be connected to the negative, *b* to the positive pole of the induction coil A. As the air pressure in the tube is reduced, the color and the general appearance of the discharge continually changes character. When the pressure reaches a small fraction of a millimeter of mercury the intensity of the discharge in the gas itself becomes very much reduced, but in its place appears a strong fluorescence of the glass. This fluorescence is produced by faint streamers which proceed in straight lines from the negative electrode, as indicated by the straight lines in Fig. I., from the disc at *a* toward the terminal *c* of the tube. These streamers are called the cathode rays. Professor Crookes, of London, advanced the theory that the streamers represent a fourth state of matter, which he called radiant matter. According to this theory there is matter moving from the negative electrode, where it is projected by the action of electric force, and whenever this moving matter strikes the glass it causes it to fluoresce. A radiometer interposed properly in the path of the streamers will be set into rotation. The fact that the fluorescing portions of the tube become very hot when the action of the coil is powerful seemed to support Crookes' hypothesis, namely, that there is along the path of the cathode rays projected matter moving with very high velocity.

Other theories concerning these rays were proposed, but none of them are entirely free from serious objections. Röntgen's discovery will probably enable us to decide very soon which among the several existing theories is the correct one. The theory which probably has the most followers on the continent will be mentioned presently.

Cathode rays are deflected by magnetic force; the direction of the deflection is roughly stated the same as if each ray were a flexible conductor carrying a current with one of its terminals attached to the cathode. The late Professor H. Hertz discovered in 1891 that cathode rays are capable of passing through thin sheets of metal like gold leaf, aluminum, silver, etc., if these sheets are placed within the vacuum in the path of the rays. Dr. Lenard, an adjunct to Hertz, extended this discovery two years ago by showing that the cathode rays can be made to pass out of the vacuum tube into the external space, if the tube is provided with a small window of thin aluminum. But as soon as they pass into the external atmosphere they are rapidly absorbed; this absorption results in a flourescence of the gas. Various gases possess various degrees of this absorptive power and the absorption in a given layer of gas is proportional to its density. Solid bodies absorb them very much more strongly on account of the

greater density. The resulting flourescence in gases seems to indicate that the cathode rays in passing through a gas undergo a diffuse reflection resembling the reflection in a turbid medium, just as if the molecules of the gas were very large in comparison to the wave-length of these rays. That the radiance which produces the fluorescence is really a continuation of the cathode rays is demonstrated by the fact that it is deflected by magnetic force.

Röntgen's discovery adds a new accompaniment to the cathode rays. It shows that, in addition to the heat and flourescent light which the cathode rays generate in the glass of the vacuum tube wherever they strike it, there is also another form of radiant energy generated there. Röntgen calls it the X-rays. The rays will and should, of course, be called the Röntgen rays. They are not cathode rays, according to the reports which have reached us so far ; for although they are capable of producing strong flourescence, just like the cathode rays, they are not acted upon by magnetic force, and not only are they not absorbed by gases at ordinary pressure, but even the most opaque of all substances, that is the metals, are more or less transparent with respect to these new rays. Cardboard, wood, ebonite, organic substances, etc., are about as transparent to them as glass is to the visible part of the spectrum. They are neither reflected nor refracted, that is not to any appreciable degree. They act upon a photographic plate, but it is evident that photography by means of these rays cannot employ lenses and that the pictures obtained will be shadow pictures. The object to be photographed is placed between the plate and the vacuum tube. It is to to be hoped that these shadow pictures of the interior of living organisms will soon be perfected so as to show us the various parts in various shades according to the absorptive power of each part.

The question arises, what is this new form of radiant energy? The report says that the discoverer has expressed, but with much reserve, his belief that it is a longitudinal vibration of the ether. If so, then its velocity of propagation will in all probability be much larger than that of light, and therefore for the same period of vibration as that of visible light these new rays may have a very much larger wave-length. Should this belief of the discoverer prove correct, then we shall finally have the longitudinal wave in the ether for which we have looked so long, in order to avoid the necessity of considering the ether an incompressible solid elastic. It is well to mention here that quite a large number of very distinguished German physicists have within the last few years advocated quite strongly the theory that cathode rays are longitudinal vibrations of the ether. Prof. Jaumann, of Vienna, has published quite recently a very elaborate mathematical formulation of this theory. It is an application of Maxwell's electro-magnetic theory to a medium whose specific inductive capacity and permeability vary under the action of electric force. Such a medium is in all probability a gas in a state of high tenuity, as for instance in a Crookes' tube. This theory will not account satisfactorily the longitudinal character of the Röntgen rays.

The correct view of this new radiant energy will undoubtly soon be formed when new experimental data appear. In the meantime we can rest assured that a new entrance to the region of the ether phenomena has been opened, and the importance of this fact can hardly be overestimated.

After the above note had been written the author succeeded in repeating some of Prof. Röntgen's experiments. The tubes employed were of an inferior quality on account of the poor vacuum. The poorer the

vacuum the longer must be the time of exposure under otherwise identical conditions. The tubes were used as electrodeless tubes, that is, a tinfoil strip was wrapped around each end of the tube, and then the tinfoils were connected to a high tension coil with disruptive spark gap and Leyden jar. The vacuum discharge is, of course, in such cases due to the condenser effect. The writer's experiments lead to the conclusion that quite as powerful effects can be produced in this manner as with electrodes, and it obviates the risk of spoiling the tube by excessive heating of the platinum wires carrying the electrode discs. It is well to observe here that with electrodeless tubes the glass under the tinfoil becomes very hot indeed in quite a short time, when powerful, rapid electric oscillations are employed. But on account of the large tinfoil surface which is in contact with the outside air the temperature of the tube never becomes dangerously high. Some of the results of the writer's experiments seem to be of sufficient interest to deserve a brief mention here.

An under-exposed plate fails completely to bring out the relative absorption of the materials placed in the path of the rays. For instance, the photograph of a cigar box made of aluminium sheet about $\frac{1}{16}$ of an inch thick and containing several opaque objects will show no detail if the exposure is too short. All that we see is the contour of the box, and the area bounded by this contour is uniformly illuminated. With a sufficiently long exposure the contour is still strong, but the area enclosed by the contour is scarcely visible and the objects in the box appear in sharp outline. Various objects were photographed and the results were similar to those obtained by Professors Trowbridge and Wright. The most interesting photograph obtained was that of a pair of spectacles in a leather case (see Plate III., Fig. 1). It bears upon the subject mentioned in the last paragraph. The exposure lasted an hour; the tube had the highest vacuum among the several tubes employed. In all previous photographs the lenses of these spectacles appeared as perfectly flat discs of high opacity. In this photograph, however, obtained with long exposure, the varying thickness of the lens is beautifully marked in the negative. The central part of the lens is darkest, and then the increase in luminosity toward the edge was gradual, showing distinctly the curvature of the lens. This photograph seems to support the writer's belief that the relative amounts of absorption in the various parts of the object photographed are brought out in a photographic plate if it is exposed a sufficiently long time, but not otherwise. In the photography of the human hand, for instance, there is no trace of the skeleton unless the exposure is sufficiently long. The contour surrounding the uniformly illuminated surface of the hand is very easily obtained with a short exposure. But to obtain an image of the skeleton of the hand the exposure must be sufficiently long, and it appears that the longer the exposure the stronger is the impression of the contour of the bones and the weaker is that of the surrounding flesh.

Prof. Röntgen's photograph of the human hand is the only one in which the flesh is almost entirely invisible. In Mr. Swinton's photograph the fleshy part of the hand is nearly as strongly marked out as the bony part. The writer cannot agree with Mr. Swinton's opinion that this is due to overexposure, and prefers to consider the presence of the fleshy part of the hand as due to underexposure. At any rate, the difference between the Röntgen photograph of the human hand and the photographs obtained by other experimentalists, including the writer, seems to deserve further investigation. A fluorescent screen placed in front of the sensitive plate for the purpose of

Fig. 1. Leather case containing eye-glasses. Cigar case of aluminium $\frac{1}{16}$ inch thick, containing scissors, knife, etc. Exposure 1 hour (M. I. PUPIN).

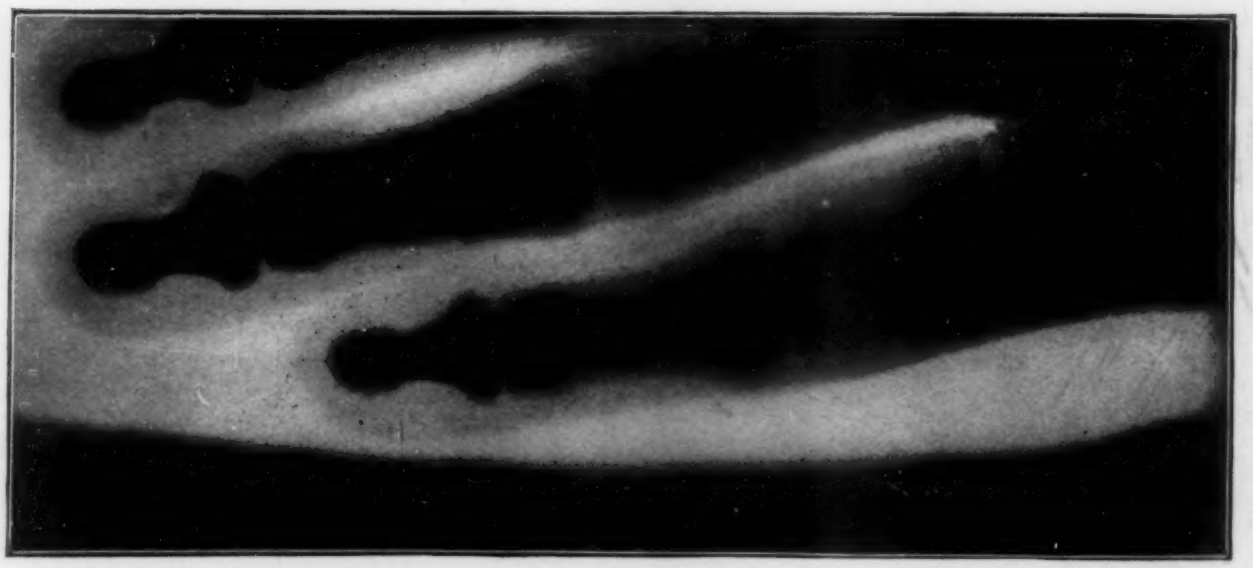


Fig. 2. Fingers taken with exposure of 20 minutes (E. B. FROST).

Fig. 1. The varying transparencies of a number of substances for the X-rays. At the top is a book ; to its right a 'rubber' cork about 2 cm. high; just below that a 'cork' cork of equal thickness, but of far greater transparency ; in the right lower corner is a crystal of Iceland spar, 1 cm. thick; in the left lower corner a loop of aluminium wire enclosing little Canada balsam (shows faintly); between the loop of wire and the spar may be very faintly seen a very thin picce of mica; above this is a hard rubber tube containing water with cork stopper; the superior transparency of cork to that of water is well shown where the cork is pressed into the rubber tube. (E. B. FROST.)

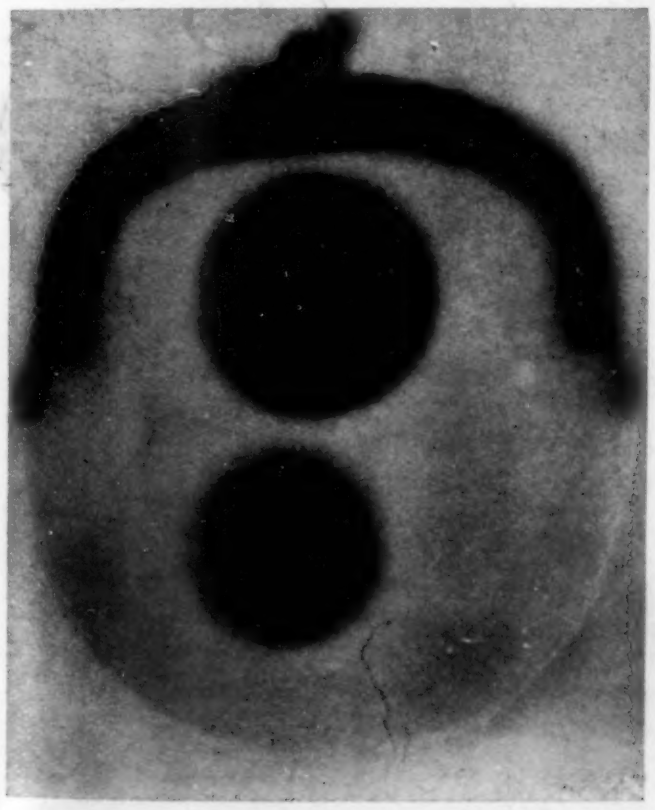
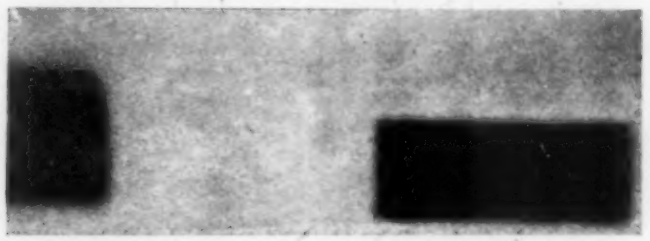


Fig 2. Coins in leather purse (A. W. GOODSPEED).



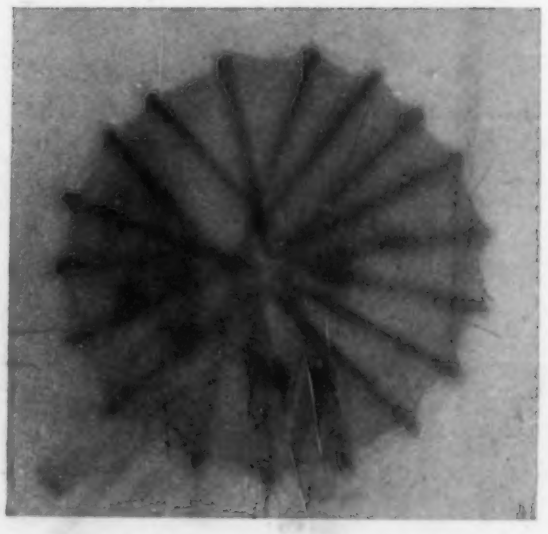


Fig. 3. Pins in cushion (A. W. GOODSPEED).

shortening the time of exposure gave encouraging results. A shortening of the time of exposure and the simplification of the apparatus employed is very desirable in the practical application of this wonderful discovery. The prospects are that both will soon be reached. It should be mentioned in this connection that a Whimshurst or a Holtz machine can very well be employed in place of the somewhat complicated apparatus employed so far. These machines should be used to charge a small Leyden jar and discharge it between small spheres which are at a suitable distance from each other. The tinfoil coatings of the vacuum tube should then be connected suitably to the coatings of the jar. This arrangement is much simpler than the one usually employed and will in all probability give just as good results—perhaps even better, because a disruptive character of the discharges seems to improve the results. This method, however, is offered as a suggestion only, since the writer could not procure a statical machine in time to convince himself of the actual value of the suggested arrangement. The practical applicability of this method of photography to surgery seems certain.

M. I. PUPIN.

COLUMBIA COLLEGE, February 8, 1896.

EXPERIMENTS ON THE X-RAYS.

EXPERIMENTS with Röntgen's newly detected X-rays have been carried on during the past few days in the Dartmouth physical laboratory by Prof. C. F. Emerson and the writer, and some of the preliminary results already obtained may be worth recording.

Of four Crookes tubes first tried, but one emitted rays which (with the exposure given) made a visible impression upon a photographic plate protected from the ordinary luminous rays. This tube is 4.7 cm. in diameter and is cylindrical for a length of 16 cm., then tapering to a point. The platinum electrodes are on opposite sides of the cylindrical surface and are about 5 cm. apart. A phosphorescent plate is interposed obliquely between the electrodes. In action the phosphorescent surface is bombarded by the discharge from the negative pole. We have thus far usually excited the tube by a current from an efficient induction coil, but a Holtz machine has served about equally well.

The first successful experiment gave, after 12 minutes of exposure, a picture of a knife and scissors hung on the side (1 cm. thick) of a whitewood box, within which the photographic plate had been placed.

Subsequently, the Crookes tube was supported horizontally, and the plate-holder could then be laid upon the table and any object interposed that was desired. No camera was employed, and the slide of the plate holder was not drawn, so that no exposure to the ordinary luminous rays could occur.

A coin and key concealed between two boards of total thickness, 24 mm., were shown after an exposure of 11 minutes, the tube being 15 cm. above the plate. The power of transmitting the X-rays has been tested for a number of substances. Silver and gold seem to be the most opaque of the metals yet tried, although aluminium transmits poorly. Glass is more opaque than brass, and less so than hard rubber. Cork transmits better than any other substance examined. (See Plate 4, Fig. 1.)

An attempt to refract the rays by a carbon disulphide prism was unsuccessful, and they seemed to pass through a pair of crossed tourmalines without difficulty. No effect except that of the usual metallic obstruction was noted when the wire conveying the primary current was passed over the plate, or when the alternate current of the house circuit was sent through a loop of insulated wire resting on the plate holder.

With the tube 9 cm. above the plate an exposure of 15 minutes clearly brought out

the bones of a hand laid upon the plate holder, and subsequent plates have revealed the bones of the hand and arm with startling distinctness. (See Plate 3, Fig. 2.)

It was possible yesterday to test the method upon a broken arm. After an exposure of 20 minutes the plate on development showed the fracture in the ulna very distinctly. Comment upon the numerous applications of the new method in the sciences and arts would be superfluous.

Edwin B. Frost.

Hanover, N. H., February 4, 1896.

EXPERIMENTS ON THE RÖNTGEN X-RAYS.

During the past week experiments have been in progress in the physical laboratory of the University of Pennsylvania on the Röntgen phenomena. The apparatus has been gradually simplified till now only a single induction coil about 12 inches long and 4½ inches in diameter is used. The resistance of the primary is about 0.3 of an ohm, and that of the secondary about 3,200 ohms. The current for the primary is supplied by eight or ten storage cells connected two in multiple arc. The Crookes tube is a pear-shaped one about 10 inches long and 4½ inches in diameter at the larger end. The exposure has been inconveniently long, an hour or more giving the best results.

Impressions of several surgical cases, including deformed fingers, fractures, etc., have been successfully produced. The results seem to be best where the tube is about 5 inches from the sensitive plate, with its longer axis vertical and the cathode at the top. A card with a broad line of white lead paint upon it was used, showing the card transparent and the paint opaque.

Special experiments made by Dr. H. C. Richards indicate that amethyst, quartz, calc spar, mica and tourmaline are quite opaque. In one of the experiments a ⅜-inch aperture in a copper screen was placed 2½ inches below the tube. The sensitive was 3½ inches below the aperture. The result showed that the rays in passing through the opening were considerably diffused. Experiments have been arranged to examine the possible deviation of the rays in passing through a wooden prism. The results as yet are not conclusive. The pictures accompanying this article (see Plate 4) are some of a number taken on February 5th and 6th. One shows a thick leather pocket purse containing a couple of coins. Upon the same plate were placed a slip of thin glass and a bit of aluminium tube. As is seen, the glass and aluminium seem equally opaque. Another of the cuts shows the outlines of a pocket pincase taken by Dr. R. R. Tatnall. Every pin shows clearly in its place. Some flowers painted upon one of the surfaces are quite visible in the negative.

In our experiments the sensitive plates have been enclosed light-tight in an ordinary plate holder and placed horizontally upon the table beneath the tube. Upon the slide of the plate holder were placed the articles to be tested.

The wide field for the development and the application of the new science will become apparent to everyone. As has already been suggested, it may prove to be an efficient mode of examination for the surgeon. It may also be used to judge the genuine from the false as in the detection of a spurious diamond or other gem from the real.

As the X-rays are not light rays, but probably are some form of radiant energy, the writer has suggested the term *radiography* instead of photography for the new process.

The comments of several scientists that the form of wave motion transmitting the energy concerned in the Röntgen phenomena is longitudinal and not transverse, have especial interest. It is shown in a recent article by G. Jaumann, in Wiede-

mann's Annalen for January, that by a small modification in Maxwell's equations to satisfy the conditions of high rarefaction, which is met with in a Crookes tube, longitudinal ether waves are possible, which would possess many of the properties of the so-called cathode rays.

ARTHUR W. GOODSPEED.

UNIVERSITY OF PENNSYLVANIA, Feb. 8.

SCIENTIFIC NOTES AND NEWS.

GENERAL.

AN admirable portrait of the astronomer Schiaparelli forms the frontispiece to *Minerva* for 1896.

DR. S. P. LANGLEY has been elected one of the Foreign Members of the Royal Society of London. There are now six from the United States, Alexander Agassiz, B. A. Gould, S. P. Langley, Simon Newcomb, H. A. Newton and H. A. Rowland.

NEW honors are being bestowed upon the discoverers of argon. First came the Barnard gold medal of Columbia College, then the $10,000 Hodgkins prize, then the prize of 50,000 francs from the French Institute and now it is announced that Lord Rayleigh and Professor Ramsay have been made Knights of the Legion of Honor, by order of the French Government.

MR. W. L. SCLATER, son of the veteran secretary of the Zoölogical Society of London, has been appointed curator of the South African Museum at Capetown. Mr. Sclater was for some time deputy superintendent of the Indian Museum at Calcutta, and has more recently been assistant master at Eton. Mr. Sclater is a well trained zoölogist. His predecessor at Capetown, Mr. Rowland Friman, was a botanist.

MR. ROBERT RIDGWAY, of the National Museum, has gone to Southern Florida to study the spring bird migrations, during February and March. His son, Audubon Ridgway, a promising young ornithologist, is his companion.

MR. FRANK HAMILTON CUSHING, of the Smithsonian Institution, is still engaged in the investigation of the ancient lake dwellings of southern Florida, where he has been since December.

THE aquarium, which was so attractive a feature in the display of the United States Fish Commission at the Atlanta Exposition, has been transferred to the custody of the Smithsonian Institution, and will be installed in the National Zoölogical Park in Washington.

THE delay of President Cleveland in appointing a Commissioner of Fisheries to succeed the late Colonel Marshall MacDonald is quite unaccountable. The requirements of the law as to the qualifications for this office are so explicit that there ought to be no difficulty in making a choice. There are few men in the country who possess 'proved scientific and practical knowledge of the fishes of the coast.' The position was created for the late Prof. Baird, who created the organization, and brought it to a high state of efficiency. It would seem a matter of necessity that his successor should be a naturalist and one who has had experience in the study of fishes and the fisheries.

THE government of Greece has granted to the American School of Archæology, at Athens, the privilege of making excavations on the site of ancient Corinth.

THE appointment of Dr. John S. Billings to be chief librarian of the consolidated libraries of New York City is a most excellent one—though it is to be regretted that his work in sanitary science should be interfered with. His admirable abilities as an administrator will have full exercise in this new position, and there can be little doubt that he will be able to organize some new advances in bibliography as well. Dr. G. E. Wise, of the Newberry Library, Chicago, in a recent article in the *Library Journal*, gives an appreciative survey of his *Index Catalogue of the Library of the Surgeon Generals Office*—the extent and importance of which is just beginning to be appreciated outside of the medical profession.

ONE of the most extensive zoölogical works of modern times will be *Das Tierreich* projected by the Zoölogical Society of Berlin, to be edited by Professor F. E. Schulze. It is to contain descriptions of all the known species of animals, prepared upon a uniform plan.

THE pictures of living walruses, in *The Cosmopolitan* for February, are from photographs

taken by Prof. L. L. Dyche of the University of Kansas, and are exceedingly interesting and instructive. They illustrate an article by Prof. Dyche, who accompanied Lieut. Peary to the arctic regions.

Le mouvement scientifique aux Etats-Unis is the title of an elaborate paper by M. Jules Violle, of the École Normale Superieure in Paris, which has recently appeared in the *Revue générale des sciences pures et appliquées*, and in the *Annales du Conservatoire des Arts et Metiers*. M. Violle, who came over in the Exposition summer, writes very appreciatively of our astronomers, physicists and inventors, and their work; and endeavors to impress upon France that it has much to learn from the United States. "America," he writes, "has already too many advantages over us. Our most important interests demand that we should struggle to preserve the advantages which we still possess over America. High intellectual culture is not a matter of luxury or of national pride. A mere glance at the other nations of the world demonstrates that not only the prosperity of a country but its very future depends upon scientific progress, at once glorious and profitable to every citizen." M. Violle's article is elaborately illustrated, but the pictures are somewhat incongruous with the text, exhibiting chiefly public buildings and scenes at the World's Fair.

The same number of the *Annales du Conservatoire*, has other important articles on the Chicago Exposition—one upon its general features by Emile Levasseur, member of the Institute, one on the mechanical display by M. Gustave Richard, and one upon Agriculture in America by M. Maximilien Ringelman, of the National Agricultural School at Grignon, who declares that notwithstanding certain remarkable features, our agriculture is on the whole in a very backward and primitive condition. These articles together fill two hundred pages and have numerous illustrations.

Progress is being made in the endowment of a fellowship of anatomy in the Wistar Institute of the University of Pennsylvania in honor of Joseph Leidy. Of the $30,000 required, $7,000 has now been subscribed. The committee of the alumni and former students of Leidy's consists of Wm. C. Posey, Chairman; J. Howe Adams, Secretary and Treasurer; Joseph P. Tunis, Joseph Leidy, Jr., and C. H. Frazier; and there is an Advisory Committee consisting of C. C. Harrison, S. Weir Mitchell, J. M. Da Costa, Geo. A. Piersol and Isaac J. Wistar. The money so far subscribed has come chiefly from Philadelphia, but the endowment should be national and international. Subscriptions may be sent to the Treasurer or to any member of the committees.

The following monographs of the U. S. Geological Survey are in press and will shortly be issued:

XXV. *The Glacial Lake Agassiz*, by Warren Upham. 1895. 4°. xxiv, 658 pp. 38 pl.

XXVI. *Flora of the Amboy Clays*, by John Strong Newberry; a posthumous work, edited by Arthur Hollick. 1895. 4°. 260 pp. 58 pl.

The following monographs are in preparation:

The Geology of Franklin, Hampshire and Hampden Counties, Massachusetts, by Benjamin Kendall Emerson.

The Glacial Gravels of Maine and their Associated Deposits, by George H. Stone.

Geology of the Denver Basin, Colorado, by S. F. Emmons, Whitman Cross and Geo. H. Eldridge.

Sauropoda, by O. C. Marsh.

Stegosauria, by O. C. Marsh.

Brontotheridæ, by O. C. Marsh.

Report on Silver Cliff and Ten-Mile Mining Districts, Colorado, by S. F. Emmons.

Flora of the Laramie and Allied Formations, by Frank Hall Knowlton.

A special meeting of the Biological Section of the New York Academy of Sciences was held on January 31st to discuss the origin of instinct with reference to the inheritance of acquired character. The meeting was called in honor of Principal C. Lloyd Morgan, of Bristol, who opened the discussion. He described his own interesting experiments with chicks and ducklings, and held that these and other evidence tend to show that instincts are not perfected under the guidance of intelligence and then inherited. A chick will peck instinctively at food, but must be taught to drink. Chicks have learned to drink for countless generations, but the acquired action has not become instinc-

tive. The discussion was continued by Profs. Baldwin, Cattell, Osborn, Hyslop and others, and was closed by Prof. Morgan.

THE Fisheries, Game and Forest Commission of the State of New York, in its annual report, recommends that power be conferred upon the Commissioners to close streams or other bodies of water in the State for a term of years, not to exceed five, when in their judgment it is necessary to resort to such procedure to enable fish planted by the commission to obtain suitable size, before fishing of any kind is permitted. It is stated that salmon planted in the Hudson River would do well if it were not for dams and nets. The Commissioners recommend as a public necessity that two bodies of water in the Adirondack region, to be selected by the Commission, be set aside by law and used as stock waters to supply eggs of lake trout and other fish for the public waters of the State. They also recommend that forest lands in the Adirondack and Catskill region be purchased, until the entire area be included in the forest preserve.

THE Proceedings of the Chemical Society (London) issued on January 14th contain an abstract of a paper by Prof. Dewar, on the liquefication of air and research at low temperatures. The author reviewed the forms of apparatus that had been used in low temperature research, pointing out that the best and most economical plant for the production of liquid air or oxygen was one based on the general plan of the apparatus used by Pictet in his celebrated experiments on the liquefaction of oxygen in the year 1878. He described his own experiments, and stated that Prof. Olzewsky's claim to priority was fantastic. In the discussion that followed Lord Playfair and Dr. Armstrong deprecated the attacks that had been made on Prof. Dewar. Mr. Blount described the Linde process for liquefying air. Trials of the process had been made on a considerable scale, and there appeared to be no difficulty in liquefying air cheaply and in quantity. At the close of the exercises Prof. Dewar said that the late Prof. Wroblewski, as early as the year 1884, predicted that liquid air would be the refrigerating agent of the future; his prophecy seems about to be realized.

WE learn from *Nature* that at their scientific meeting on March 3d the Zoölogical Society of London propose to discuss the much-vexed question of zoölogical nomenclature. This subject will be introduced by Mr. Slater, the Secretary of the Society, who will read a paper on the 'Rules for naming Animals,' lately adopted by the German Zoölogical Society, and point out the divergences between them and what is called the Stricklandian Code of Nomenclature, recognized by the British Association, and usually followed in Great Britain.

THE Agricultural Society of Austria has concluded arrangements for holding an international agricultural machinery fair in Vienna, which is to be opened on March 9th, and will last for six days.

PROF. D. G. BRINTON began on February 7th a course of eight lectures on the 'Scientific Study of Man,' to be given on successive Fridays at the Academy of Natural Sciences. The lectures are as follows:

1, 'The Universe and Man from the Standpoint of Science;' 2, 'Man's Position in the Chain of Animal Life;' 3, 'The Origin of Man;' 4, 'The Races or Varieties of Man;' 5, 'The Geographic Distribution of Man;' 6, 'Man as a Wild and as a Domesticated Animal;' 7, 'The Metaphysical in Man;' 8, 'The Man of the Present and the Future.'

AT the annual meeting of the American Forestry Association in Washington the membership was reported to be 632, and it was announced that the Association would be incorporated in the District of Columbia. The establishment of a monthly or bi-monthly publication, as the official organ of the Association, was recommended, and a plan was submitted for the affiliation of State Forestry Associations with the National Association.

M. JULES REISET, the eminent chemist and agriculturist, member of the Paris Academy of Sciences, died at Paris on February 5th, aged 78 years.

RESOLUTIONS have been adopted by the New Mexico Agricultural Experiment Station to the effect that great injury has already been done to the agricultural and horticultural interests of the Southern States by the introduction of

injurious insects, and that to prevent such introduction horticultural quarantine officers should be stationed at various Southern ports, and that in addition an agent of the Department of Agriculture should be sent to study the injurious insects in Mexico, Central America and the West Indies.

Prof. S. W. Holman, of the Massachusetts Institute of Technology contributes to the December number of *The Philosophical Magazine* an article on galvanometer design in which he concludes that it is practically useless to wind turns within a distance of about one-quarter of the needle-length of the coil centre, and that to increase sensitiveness the needle must be made as short as is consistent with torsion of suspension. Those who describe sensitive galvanometers, and especially instrument makers in cataloguing are urged to present the data.

d = deflexion in mm. with scale at 1 metre from galvanometer.

c = current in amperes producing that deflection.

g = the galvanometer resistance as connected up when d is observed.

t = the time of single swing of the needle when c is measured.

The Board of Health of New York City has passed a resolution providing that all dealers in milk must secure a license from the Board, and licenses will only be granted to those whose dairies have been properly inspected.

We have received the first number of *The Technical Journal*, a bi-monthly publication adopted as the official organ of the Alumni Association of the Hebrew Technical Institute. Mr. Max Loewenthal, 248 East 78th St., is the editor and publisher.

The British Medical Journal states that inoculation of the virus of small-pox was practiced in Russia in very early times, the system having probably been introduced into the Caucasus from Greece or Turkey, the Tcherkesses adopting the habit of protecting their women from the disfigurements of natural small-pox. The method used was pricking in the virus elsewhere than on the arm. In China, on the other hand, the practice was, and still is, to some degree at least, to insert moist small-pox crusts in the nostril, even to blowing the virus up the nostril. Queen Catherine of Russia was inoculated in 1768, and very many followed her example, especially those near the Court; and as early as 1772 government facilities for securing inoculation were given, free operations being inaugurated in St. Petersburg, Kazan, and even Irkutsk, in Siberia.

The investigations carried on by the geological department in the University of Wisconsin during the autumn quarter were as follows: By C. R. Van Hise: A final revision of Principles of pre-Cambrian North American Geology, a manuscript of about 500 pages of typewritten material, to appear in the 16th Annual Report of the Director of the U. S. Geological Survey; a final revision of a report upon the Marquette iron-bearing district of Michigan, about 1,000 pages of typewritten manuscript and 40 maps, to be published as a monograph with accompanying atlas by the U. S. Geological Survey. By Wm. H. Hobbs: A study of material collected in connection with an investigation of the structural geology of portions of Litchfield county, Conn., and Berkshire county, Mass., to be published in a report of the U. S. Geological Survey. With C. K. Leith, a study of ancient volcanic rocks from areas in the Fox River valley. By J. Morgan Clements: Continuation of an investigation on the pre-Cambrian volcanics of the Michigamme district. By S. Weidman and E. R. Buckley: A study of the geology of the vicinity of Wausau, Wis.

UNIVERSITY AND EDUCATIONAL NEWS.

According to the fifth edition of *Minerva* the attendance of students at the beginning of last year at the thirty largest universities in the world was as follows:

1. Berlin	8,652	12. Leipzig	2,957
2. Vienna	6,714	13. Edinburgh	5,924
3. Madrid	5,829	14. Cambridge	2,893
4. Naples	5,040	15. Prag	2,859
5. Moscow	4,118	16. St. Petersburg	2,804
6. Budapest	3,892	17. Michigan	2,772
7. Munich	3,561	18. Kijew	2,417
8. Athens	3,331	19. Pennsylvania	2,400
9. Harvard	3,290	20. Turin	2,355
10. Oxford	3,256	21. Yale	2,350
11. Manchester	3,000	22. Minnesota	2,171

23. Glasgow	2,080	27. Columbia	1,816
24. Rome	1,916	28. California	1,731
25. Barcelona	1,887	29. Cornell	1,686
26. Helsingfors	1,861	30. Halle	1,666

The number of students in the Paris faculties was 11,010. Auditors are included in the number of students, which detracts from the value of the statistics. Thus there were 4,963 auditors at Naples, and only 77 matriculated students. At Berlin there were 4,807 auditors, but the number given above does not include students (2,632) in the Technical School, those (780) in the Agricultural School, nor those (398) in the Veterinary School. The order of the American universities and colleges having more than 1,000 students is: Harvard, Michigan, Pennsylvania, Yale, Minnesota, Columbia, California, Cornell, Chicago, Wisconsin, Nebraska, New York, Toronto, Boston, Wesleyan, Princeton, Stanford, Montreal.

THE south division of Hope College, at Brown University, was badly damaged by fire on the 4th inst. The total loss to the University, and to the students who occupied the building as a dormitory, was about six thousand dollars.

ON February 3d the Trustees of Columbia College adopted the following resolution: "That in all official publications hereafter issued by or under authority of the Trustees, all the departments of instruction and research maintained and managed by this corporation may, for convenience, be designated collectively as 'Columbia University,' and the School of Arts, as the same is now known and described, may hereafter be designated as 'Columbia College,' or 'The College.'" They also resolved that the new site of the University should be dedicated on May 2d, at which time the corner stone of three of the new buildings will be laid. Ex-Mayor Hewitt, class of '42, has been invited to deliver the oration.

Nature states that the Council of the Royal Geographical Society offer in the University of Cambridge for the present academical year a Studentship of £100, to be used in the geographical investigation (physical or historical) of some district approved by the Council. Candidates must be members of the University of not more than eight years' standing from matriculation, who have attended the courses of lectures given in Cambridge by the University lecturer in geography. Applications should be addressed to the Vice-Chancellor not later than March 13, 1896.

DISCUSSION AND CORRESPONDENCE.

THE DECLINATION SYSTEMS OF BOSS AND AUWERS.

THE recent paper by Dr. Chandler on the declination systems of Boss and Auwers has been followed by another paper on the same subject by no less an authority than Prof. Newcomb. This paper appears in the *Astronomical Journal* of February 3d. Prof. Newcomb comes to the same conclusion as Dr. Chandler, namely, that the system of Auwers has now become so erroneous as to be quite unfitted for use as a standard. It is of course well known that Auwers' system is in need of revision; indeed we believe that such a revision is now in progress under the direction of the author himself. We cannot see, however, that Prof. Newcomb's paper throws any new light on the matter. As we pointed out in our notice of Dr. Chandler's paper, it is at present a matter of individual opinion how much weight should be attached to Bradley's observations. The vast majority of astronomers think that they are entitled to some weight in the formation of a system. Yet they receive no weight whatever in Boss' system which Dr. Chandler and Prof. Newcomb think should now be employed in place of Auwers'. Prof. Boss has not made public his opinion as to the weight due to Bradley's observations, so far as we know. That he attached no weight to Bessel's reduction of Bradley appears of course from his work on standard declinations, but whether he would do the same with Auwers' reduction of Bradley we do not know at present.

Coming now to the actual arguments advanced by Prof. Newcomb, we will first state very briefly what they are. Passing over those which appear to be of minor importance, we would call special attention to the results presented in Section III. of Prof. Newcomb's paper. Here are tabulated the corrections to Boss' declinations of twenty stars, divided into two groups of ten each, and each covering about

two degrees of declination. The corrections are given for the epoch 1755, when they depend on Auwers-Bradley; 1875, when they depend on Pulkowa; 1880, depending on Greenwich; 1885, on Pulkowa; and finally, 1890, depending on Greenwich. The corresponding corrections for 1847, which is the mean epoch of Boss' system, are taken as zero. From the fact that these corrections to Boss do not vary uniformly with the time, Prof. Newcomb draws the conclusion that Bradley's observations must be inconsistent with the truth, which seems to imply that they are to be accorded no weight in forming a normal system. Yet we may well ask whether the numbers given by Prof. Newcomb are accurate enough to furnish any information of reliability. In his zone A the correction to Boss for 1755 is $-2''.23$. But the ten numbers of which this is the mean have a range of no less than $4''.00$. So we can hardly escape the conviction that the whole conclusion may be vitiated by a large error in a particular star. That this has occurred is not altogether impossible. For zone B the corresponding mean is $0''.27$, with a range of $2''.30$ in the ten numbers whose mean has been taken. We cannot regard conclusions based upon evidence so discordant as final. It is to be noted also that only one of the twenty stars used by Prof. Newcomb is to be found in Boss' mean system. The other nineteen stars are among those taken by Prof. Boss from the catalogues which were not used in forming the mean system, but which were reduced to the mean system by the aid of systematic corrections. Indeed in all researches with Boss' system we are met at every step by the insuperable difficulty that his original mean system does not contain stars enough to get rid of casual errors in individual stars. While therefore we agree with Prof. Newcomb's final conclusion that the system of Auwers cannot be regarded as definitive, and that it requires revision, we wish to point out that the same is true of the Boss system. And finally we wish to repeat our former statement that it is not at present practically possible to employ the Boss system, because the reductions to that system for the recent accurate catalogues have not been published. This has been done with care for the Auwers system, and until it has been done for the Boss system astronomers wishing to deduce for any purpose the most accurate declination of a star from all the catalogues will have to use the Auwers system.

H. J.

THE AGE OF THE PHILADELPHIA BRICK CLAY.

In Prof. Salisbury's last excellent report on the Surface Geology of New Jersey some of the most important points are likely to be overlooked by reason of the different names applied to the same formation by successive investigators. Fully to appreciate the light which Prof. Salisbury's investigations shed upon some of the points recently under discussion, it is necessary, after the manner of the mathematicians, to substitute in one equation its equivalent in another.

What was formerly referred to as the 'Philadelphia Brick Clay' was later correlated with the 'Columbia.' This, however, is now properly described by Prof. Salisbury in the New Jersey report (from its place of greatest development in that State), under the name of 'Jamesburg,' of which he says there can be no doubt that it corresponds to the Columbia. This deposit as developed on the Pennsylvania side of the Delaware River, from Philadelphia to Trenton, was very carefully studied fifteen years ago by the late Prof. Carvill Lewis, his views regarding it being embodied in various papers published about that time and finally in the last chapter of Abbott's 'Primitive Industry' (pp. 524–527), published in 1881. His conclusions were "that this clay may be assigned to a period when the land stood 150 feet or more below its present level, and when the cold waters from the melting glacier bore ice rafts which dropped their boulders."

After going over much of this field with Prof. Lewis, I adopted these views and incorporated them into my various references to the subject. (See especially Proc. of the Boston Soc. of Nat. Hist., Jan. 19, 1881, p. 141; Ice Age in North America, p. 523, and later in Am. Jour. Sci., March, 1894, pp. 180, 181.) It is gratifying to see that Prof. Salisbury's studies upon the New Jersey side of the river lead him to substantially the same conclusions. First, in opposition to Mr. Upham, he now holds that (p. 126)

"it seems certain that the formation (Jamesburg) was produced during the submergence of the area which it covers;" secondly (p. 128), that "the period of submergence must have been short;" and thirdly (p. 129), that "the amount of erosion accomplished since the deposition of the Jamesburg is slight. This is shown * * * by the undissected flats of this material, even where in close association with considerable streams. * * * Either the formation is very recent, or conditions since its development have been most unfavorable for erosion * * *. The small amount of erosion which it has suffered seems hardly consistent with its correlation with the earliest glacial epoch."

In order to understand the distinct advance here made, one has but to refer to Prof. Chamberlin's article in the *American Journal of Science*, for March, 1893, pp. 191, 192, where he enumerates among the features which he thinks 'may be accepted as demonstrative,' first, that "an older fluviatile deposit (the Philadelphia Brick Clay) is to be associated in age with the old glacial drift," and "that after the formation of this older river deposit, which took place at a low altitude and a low gradient, there was an epoch of elevation and erosion, during which the Delaware cut its channel down to the depth of 200 or 300 feet below the upper old terrace." It would seem now that this interpretation must be abandoned for the Delaware, as a similar interpretation had to be abandoned for the gravel terraces near the junction of the Conewango and the Allegheny Rivers two years ago. Mr. Salisbury is undoubtedly correct in believing that these high level gravel and clay deposits in the Delaware Valley, in the vicinity of Trenton, are of comparatively recent deposition. They are not older, but younger, than the erosion of the rock channel of the Delaware.

I may say in conclusion, also, that the investigations of Prof. E. H. Williams, in the Lehigh Valley, which have been too little noticed, seem positively to show that the river channels of that whole region had been worn to nearly their present depth of rock bottom before the earliest period of glaciation. I trust that renewed attention will be attracted to this difficult problem concerning which so many facts have now been accumulated.

G. FREDERICK WRIGHT.

OBERLIN, O., January 29, 1896.

ANCIENT MEXICAN FEATHER WORK AT THE COLUMBIAN HISTORICAL EXPOSITION AT MADRID, 1892.

TO THE EDITOR OF SCIENCE: Under the above title a contribution of mine has appeared in the recently issued Report of the U. S. Commission on the Madrid Exposition, Government Printing Office, Washington, 1895. Owing to the fact that the proofs were not sent to me for revision, my paper contains several typographical errors, three of which particularly demand correction. It being too late to rectify these errors by any other means, I have adopted the present method of doing so, with the hope and earnest request that possessors of copies of the report will duly note them therein, in order to prevent future misunderstandings. On page 332 read that I identified the shield 'of Phillip II.' at the Royal Armory, Madrid, as being of Hispano-Mexican workmanship, in 'October, 1892,' instead of '1893,' as printed.

On page 335 read the 'tiny,' instead of the *wing* feathers * * * that grow on the heads and breasts of tropical humming birds.

On page 337 read Mr. Phillip Becker instead of 'Bectier(?)' I need scarcely state that, in my original text, the name of my late, highly esteemed friend, is correctly given and is not followed by an interrogation point.

Thanking you, in advance, for kindly affording me the opportunity to do myself justice.

Yours truly,

ZELIA NUTTALL.

JANUARY 14, 1896.

SCIENTIFIC LITERATURE.

NEW DATA ON SPIRULA.

Zoölogy of the Voyage of H. M. S. Challenger: Part I., XXXIII. Report on Spirula. By T. H. HUXLEY and P. PELSENEER. VIII., 32 and 12 pp. 4°, and six plates. 1895.

The eighty-third and last part of the zoölogical series of reports on the scientific results of the Challenger expedition could not be issued in one of the zoölogical volumes on account of delays in its preparation. These delays were

intimately associated with the failing health of Prof. Huxley, who after making a splendid series of anatomical drawings, illustrating nearly every detail of the gross anatomy, felt himself unable to supply the text. He therefore placed his notes and drawings at the disposition of Dr. Pelseneer who has furnished a description of them, together with some additional details drawn from his examination of two other specimens submitted to him by Prof. Giard.

It is probable that there were reasons why the work was not made more complete which do not appear in the preface, and in this way the absence of histological details may be accounted for. As regards the gross anatomy there is, doubtless, little left for future anatomists now that Huxley has cleared the path, and the present monograph will remain for the future the standard of reference for this genus. This being the case, the rarity of the animal being considered, it is perhaps worth while to point out wherein Dr. Pelseneer has come to too hasty and even erroneous conclusions from the data he possessed. The U. S. National Museum possesses a nearly perfect specimen of Spirula taken from the mouth of a deep-sea fish trawled in the Gulf of Mexico, and also a fragment found at Palm Beach, Florida. The possession of the former enables me to correct certain details of the monograph.

Spirula is a remarkable animal for a cuttlefish. It is short and stout, with the posterior (caudal) end blunt, truncate and furnished with what looks like a sucking disk nearly as large as the diameter of the animal's body. In the cavity of this organ is seen a central prominence of cartilaginous consistency, the homologue of the terminal cone of Belemnites or *Onychoteuthis robusta*. On each side the 'fins' or lateral expansions of the mantle occupy a dorso-ventral plane and lateral and terminal position instead of being, as in the quickly swimming forms, in the dorsal plane or parallel to it. In short, they look as if they were adapted to serve as buttresses if the animal should fasten itself to some hard object by its terminal disk, with its body in a vertical attitude, like a sea anemone.

Spirula is extremely rare in collections, though its siphunculated shell is abundant on the beaches or floating on the sea in certain regions. Nearly all the specimens which have been taken with soft parts more or less preserved are of two sorts; one has the cylindrical muscular cortical portion complete and uninjured, but the head and viscera are missing, leaving the rest buoyed up by the shell. The other sort has the viscera and terminal portions in a perfect state, but the outer layers of the cortex lacerated or removed. The National Museum specimen is of the latter kind; the epithelium, chromatophoric layer and part of the strong muscular layer below it, are scraped off and partly hang in strings scratched longitudinally from the tail end forward to the margin of the cylinder. The delicate outer layer over the posterior end is perfectly intact, as are the fins. There can be no reasonable doubt that this scraping is due to the teeth of the fish in whose mouth it was found. Both the Challenger and the Blake specimens were in this condition, and Prof. Giard's were also incomplete, though to what extent Pelseneer does not state. The aboral disk is strongly attached to the shell, and when the specimen is fresh and elastic, if the end of the finger is pressed upon the disk and withdrawn, a distinct sensation of suction is felt, though the hardening effect of the alcohol puts an end to this after a time.

Now, the only hypothesis which seems to reconcile all the facts in the case is that the aboral disk may serve as a means of attachment to hard bodies, so that the Spirula, while not unable to swim, is in general sedentary. This explains why living specimens are not taken free in the ocean. When alive, on this hypothesis, it usually adheres to hard bodies. If it relaxes its hold, through disease or weakness, it slowly rises by the gas contained in the chambers of the shell, and the viscera under this condition decay first. If forcibly pulled off from its perch by a fish, the epithelium is likely to be lacerated, something difficult to explain if the animal were taken free swimming, as the swimming cephalopods taken from fish stomachs are not lacerated in this manner when small enough to be swallowed whole. It is undoubtedly a deep-water animal.

The testimony of Rumphius is rightly rejected by Pelseneer, but we cannot agree with

him that it is necessary to abandon the hypothesis above mentioned, at least until some other function is proved for the terminal disk. Pelseneer seems to think that the rostral papilla may be covered with an external shell in the living animal, but for this there is no evidence as yet, and hardly any justification.

In most specimens the peripheral cortex has two lobes covering the lateral planes of the shell and leaving a certain portion of the outside of the whorl, dorsal and ventral, in front of the terminal disk, more or less exposed. Owen describes the epithelium as extending out over these areas of shell but not entirely enclosing them. Steenstrup describes a specimen in which the shell "was distinctly covered dorsally and ventrally, where the skin grew thin above it." Upon this Pelseneer observes, "As one might expect, this last assertion is absolutely incorrect," and "there is no portion of the integument, however thin this may be, which passes over the shell, contrary to the opinion of Owen and Steenstrup."

How difficult is the rôle of infallibility, may be judged by the fact that, in the National Museum specimen of Spirula, not only do the epithelial and chromatophoric layers extend, where untorn, completely over the dorsal exposure of the shell, but the underlying outer muscular coat,* as thick and tough as parchment, does the same; while, on the ventral side, the rags of this covering torn by the fish's teeth show that here also the shell was completely covered. The solid basal coriaceous part of the integument preserves its usual form. Huxley's figures of *Spirula Peronii* (Pl. I., figs. 1–3, 5–6) indicate the same state of affairs with great clearness, and the ragged edges of the torn integument are perfectly depicted. These are, however, interpreted by Pelseneer thus: "The margins of the openings appear to be fixed, and to have thus sent short irregularly cut prolongations over the shell." It would be rash, not having seen the specimen, to assert that these 'prolongations' are simply the rags of the former covering, but it is certain that in one species of Spirula (that referred to as *S. australis* by Pelseneer) in the adult animal the shell is completely covered by the integument, as was the opinion of Steenstrup.

Adams and Reeve have figured a very young Spirula, which Owen believed to be complete, in which the terminal disk was absent and the lateral lobes cover only a small part of the last whorl of the shell. Pelseneer has figured hypothetical stages of development for Spirula showing a gradual enlargement of the lateral lobes of integument. In most specimens so far observed, portions of the shell are certainly uncovered. It is not an extreme hypothesis to suppose that in the fully adult animal the integument in most cases will wholly enclose the shell.

The shell of Spirula is enrolled with the ventral side concave, and Pelseneer observes that the "other molluscs with rolled up univalve shells present, when they have not undergone torsion, a dorsal or exogastric rolling up, *e. g.*, *Nautilus*, embryonic *Patella* and *Fissurella*."

The learned doctor forgets that *Patella* and *Fissurella* are rolled up in opposite directions, and that *Fissurella*, if prolonged into a tube and coiled as it begins, would have an 'endogastric' whorl like Spirula. *Aliquando dormitat Homerus.*

In 1878 I saw in the Godefroi Museum, since acquired by the city of Hamburg, a large series of Spirula from the South Seas. They were partly fragmentary, but I believe comprised several perfect specimens which might throw light on doubtful points. The specimen in the National Museum came from a fish trawled in 324 fathoms in the northern part of the Gulf of Mexico, between the delta of the Mississippi and Cedar Keys, Florida. The color is yellowish white, with ferruginous and dark purple dotting profusely distributed. The specimen is a female. The temperature of the water at the bottom was 46°.5 F. It had evidently just been seized by the fish, for, except the lacerated epidermis, it is in most perfect preservation.

In conclusion we may note that perhaps the most important result of Dr. Pelseneer's analysis of the characters of Spirula is its final reference to the Oigopsid group. Owen had stated facts also confirmed by the data of paleontology which should have resulted in this classification more than fifteen years ago; but there has been a singular delay in accepting it. After the full

*Corresponding to Pelseneer's first and second layers.

details, now laid before the systematist, he should not longer delay his acceptance of the reform. WM. H. DALL.

Hunting in Many Lands—The Book of the Boone and Crocket Club. Edited by THEODORE ROOSEVELT and GEORGE BIRD GRINNELL. New York, Forest and Stream Publishing Co. 1895. 8°, pp. 447, illustrated.

The Boone and Crocket Club is an organization whose principal objects are: the preservation of the large game of America, the promotion of exploration in little known lands, the record of observations on the natural history of our wild animals, and the promotion of manly sport with the rifle. It is interested also in forest preservation. Membership is limited to one hundred, and no one is eligible who has not killed 'in fair chase' at least one kind of American big game.

The Club has done much good in diffusing a healthy sentiment against illegitimate hunting and unnecessary destruction of game, and in aiding the enforcement of game laws in the various states. It has been largely instrumental also in accomplishing the passage by Congress of an act for the protection of the Yellowstone National Park; and still more recently has secured the passage by the State Legislature of an act incorporating the New York Zoölogical Society, which Society will soon establish, in the neighborhood of New York, a great Zoölogical park.

Several years ago the Boone and Crockett Club published a volume entitled 'American Big Game Hunting,' which was made up of articles by well known writers on the game of our own country. This, and Mr. Roosevelt's personal writings, particularly his 'Wilderness Hunter,' which is incomparably the best book ever written on the large mammals of America, made it desirable to select a wider field. The present volume, 'Hunting in Many Lands,' contains chapters on Hunting in East Africa, by W. A. Chanler; To the Gulf of Cortez, by George H. Gould; A Canadian Moose Hunt, by Madison Grant; A Hunting Trip in India, by the late Elliott Roosevelt; Dog Sledging in the North, by D. M. Barringer; Wolf-Hunting in Russia, by Henry T. Allen; A Bear Hunt in the Sierras, by Alden Sampson; The Ascent of Chief Mountain, by Henry L. Stimson; The Cougar, by Casper W. Whitney; Big Game of Mongolia and Tibet, by W. W. Rockhill; Hunting in the Cattle Country, by Theodore Roosevelt; Wolf Coursing, by Roger D. Williams; Game Laws, by Charles E. Whitehead; Protection of the Yellowstone Park, by George S. Anderson. It contains also an interesting account of the Yellowstone National Park Protection Act, some Head Measurements of Trophies, and the By-Laws and List of Members of the Club.

The book is well gotten up, entertainingly written, and abounds in facts of interest to the naturalist. The editors are to be congratulated in securing such a choice selection of articles, and on bringing out the book in such attractive form. C. H. M.

Guide d'océanographie pratique. J. THOULET. Paris, G. Masson & Gauthier-Villars et fils. 1895. Pp. 224.

This is a simple, brief, and satisfactory account of the kinds of observations that are required in oceanographic investigations of the lesser depths, of the methods of making the observations, and of the instruments and implements used. There are kept constantly in view, especially with reference to the subject of maritime fisheries, the practical results that flow from the development and study of the topographic forms of the bottom of the ocean, and of the various deposits of soil that are found there; of the study of currents and winds, of transparency and coloration, of the temperature, salinity, and chemical composition of the waters of the ocean; and of the relation between meteorology and oceanography.

The book is provided with reliable and useful tables for the conversion of fathoms into metres, for the comparison of the Fahrenheit, Reaumur and centigrade thermometric scales, for the determination of the humidity of the air and the tension of vapor of water, and for finding the density and salinity of sea water.

The scope of the work, which relates principally to the continental plateau or region which lies along the borders of the oceans between the coasts and the line marking the

depth of 100 fathoms, is mainly to inform the general reader what oceanographic research consists of, how it is carried on, and, in general, what has been accomplished; but it will also be found useful in the hands of the observer of oceanographic data and of the student of oceanographic problems.

An important feature of the book is the bibliographic list at the end.

As the operations referred to are in the main those which are carried on in the waters of lesser depth bordering the oceans, a less general title would have been more appropriate.

No inadvertence in the revision of the proofs has been detected except the manifest confusion between t and t′ and f and f′ in the explanation of the hygrometric formulæ on page 110.

G. W. LITTLEHALES.

SCIENTIFIC JOURNALS.

JOURNAL OF GEOLOGY, DECEMBER–JANUARY.

Review of the Geological Literature of the South African Republic: By S. F. EMMONS. The great and rapid development of gold mining in the Transvaal has attracted the attention of the world to this region, not otherwise of immediate interest. This article sums up the literature concerning the gold fields. The most important of these is the Witwatersrand, usually called 'the Rand,' in which Johannesburg is situated. This is in the southern part of the Republic. It is about 2,000 square miles in extent. The rocks are auriferous conglomerates of which there are several beds. On the whole the gold is distributed rather uniformly in these beds. They are crossed by basic dikes as well as quartz veins, and at the intersection of the latter the quartz is said to be peculiarly rich. As to the origin, the author quotes Smeisser as saying that the evidence points to the fact of deposit with the conglomerate 'fossil placer deposits' and also to deposit from solution subsequently. Working has progressed to a depth of nine hundred feet, but drill holes show that workable beds extend much deeper. The average gold content of this region is ten to fifteen dollars per ton. The output for 1894 was £7,800,000; that of 1895 is estimated at £8,750,000. Hatch estimates the whole product of the Transvaal at £700,000,000, a sum greater than the whole product of the United States up to date.

Igneous Intrusions in the neighborhood of the Black Hills of Dakota: By I. C. RUSSELL. This is a description of a series of hills on the northern border of the Black Hills which appear to be of a type not clearly recognized heretofore. All are due to the intrusion of igneous rock into stratified beds, but they differ from the laccolites of Gilbert in that the molten material did not spread out into a broad dome. They differ equally from the volcanic necks of Dutton, since they did not reach the surface. The name Plutonic Plug is proposed for the intruded mass. Perhaps the most impressive of these plugs is that of Mato Teepee, which has been completely uncovered and rises almost perpendicularly from its platform to a height of 625 feet. Basaltic structure is beautifully developed, the columns reaching a diameter of ten feet. How the sedimentary beds were lifted or displaced to admit of the intrusion of such a mass is not clear to the author.

The Geology of New Hampshire: By C. H. HITCHCOCK. Historical accounts of the surveys of several States have already been given in the Journal. The present article continues the series. The first survey of new Hampshire was begun in 1839 by Dr. C. T. Jackson, of Boston. This lasted three years. The second survey, under the direction of the author, was begun in 1868 and continued ten years. Great difficulties were encountered in the wildness of the region, and the fact that the study of crystalline rocks had not at that time progressed very far, and the crystalline area in the State was considerable. Much attention was paid to surface geology. Such questions as the direction of movement of the ice sheet, the diversity of the 'ice age,' terminal moraines, river terraces, etc., were carefully studied and much light was thrown upon them during the course of this survey.

North American Graptolites: By R. R. GURLEY. No general revision of the American graptolites has been attempted since Hall's work was completed, thirty years ago. This paper is an attempt at such a zoölogic and geologic revision, though its aim is mainly geologic. All the species known in American strata are discussed with reference to generic disposal and

ascertained range. A complete list accompanies the paper.

T. C. Chamberlin reviews 'The Hill Caves of Yucatan,' by Henry C. Mercer, and also a paper by G. Frederick Wright, 'New Evidence of Glacial Man in Ohio.'

The evidence in question in the latter paper is a rude stone implement found in a gravel terrace near Brilliant, on the Ohio River, by Mr. Sam. Huston, a surveyor and collector, three or four years ago. The reviewer suggests that some of the natural modes of intrusion are not excluded by Mr. Huston's observations, and that it was not shown that the terrace is primary. The fact that there are terraces along the river at much higher levels gives ground to suspect that the terrace may be more or less secondary and reworked in post-glacial times. Respecting intrusion, it is pointed out that the decay of tree roots, which had deeply penetrated the porous sand and gravel, might afford the means of intrusion to the moderate depth at which the implement was found (eight feet), without any notable disturbance of the stratification.

T. Wayland Vaughan reviews at length an important paper by J. A. Merrill, 'Fossil Sponges of the Flint Nodules of the Lower Cretaceous of Texas;' and S. Weller reviews the 'Thirteenth Annual Report of the State Geologist of New York.'

THE PSYCHOLOGICAL REVIEW, JANUARY.

The new volume opens with an article by Prof. G. S. Fullerton on *Psychology and Physiology*, in which it is argued that the discussion of the nervous system in works on physiology contains more anatomy and psychology than physiology. Foster's *Text-Book of Physiology* is taken as an illustration to show how consciousness is used where physiological knowledge fails, the sensory-motor arc being described as partly physical and partly psychical. If the parallel or automaton theory be adapted by the physiologist he should aim to make his science wholly independent of psychology; if he admit a causal interaction between body and mind he should leave to psychology the investigation of the mental process. Each science has its appropriate methods, and neither should trespass on the field of the other.

Prof. Münsterberg communicates four researches from the psychological laboratory of Harvard University. Dr. W. G. Smith has investigated the place of repetition in memory. When ten 'nonsense' syllables were read, there were remembered with entire correctness after one repetition 2.2; after three repetitions, 2.5; after six, 2.8; after nine, 3.4; after twelve, 3.9. The increase with continued repetitions is perhaps less than might have been expected, but there was a considerable degree of individual variation, one observer remembering but one, and another 6.2 syllables after twelve repetitions. Miss M. W. Calkins contributes experiments on the relative significance of frequency, recency, primacy and vividness in association. A color and a numeral were shown in conjunction, and after a series had been given the colors were repeated in a changed order and the suggested numerals recorded. Frequency was the most constant condition and vividness next in importance. Mr. L. M. Solomons shows that if a white disk is placed in a weak light, and a rotating black and white disk in a stronger light, it is not possible to get the two to look alike. Mr. J. P. Hylan reports on fluctuations in the intensity of weak sensations.

There are shorter contributions by Prof. Strong on physical pain and pain nerves; by Prof. Jastrow on community of ideas of men and women; by Mrs. Franklin on the functions of the rods of the retina; by Mr. Urban on the prospective reference of mind; by Prof. Hyslop on localization in space, and by Mr. Lay on synæsthesia. Recent psychological literature is reviewed at length by Professors James, Binet, Cattell, Hibben, Angell and others.

PSYCHE, FEBRUARY.

A. Davidson describes the habits of a California wasp of the genus Odynerus, which with its parasite, bred by Dr. Davidson, are described by W. H. Ashmead. W. S. Blatchley continues his notes on the winter insects of Vigo county, Ind., the present instalment covering the Carabidæ. H. G. Dyar gives a synopsis of the larvæ of the moths or the genus Notolophus (Orgyia), with critical notes on most of the species. A. P. Morse continues his discussion

of the Tryxalinæ of New England by an account of the new genus Pseudopomala, the single species of which is described in detail. J. W. Folsom describes three new species of the Thysanuran genus Papirius found in Massachusetts. Sharp's treatment of the insects in the new volume of the Cambridge Natural History is reviewed, and the proceedings of the Cambridge Entomological Club for January are added. In a supplement, containing contributions from the New Mexico Agricultural Experiment Station, new insects are described by T. D. A. Cockerell and L. O. Howard, including diagnoses of a large number of new Coccidæ by the former.

SOCIETIES AND ACADEMIES.

CHEMICAL SOCIETY OF WASHINGTON, 84TH REGULAR MEETING, THURSDAY, DECEMBER 12, 1895.

THE President, Chas. E. Munroe, in the chair, with thirty-six members present. Messrs. H. Carrington Bolton, W. W. Skinner and F. B. Bomberger were elected to membership. Dr. W. F. Hillebrand discussed and exhibited the spectra of Argon and Helium.

Dr. H. W. Wiley read a paper on the 'Use of Acetylene Illumination in Polariscope Work with Illustrations.' He said that Acetylene, while not inferior to other forms of illumination in point of accuracy, is so intense as to permit of accurate polarization with solutions so dark in color that they cannot be polarized with lights ordinarily used for this purpose. The Acetylene light and the 'Schmidt-Haensch Triple Field Polariscope' were exhibited. This polariscope was said to be of great assistance in rapid and accurate work.

Mr. F. P. Dewey presented a comprehensive paper on 'The Early History of Electric Heating for Metallurgical Purposes.' He traced the history of the application of the current to the production of metals from heated compounds, the necessary heat being developed by the current itself. Beginning with the very early work of van Marum, published in 1795 at Haarlem, the idea was followed through the work of Sir Humphrey Davy, 1808–1808; Children, 1809–'15; Depretz, 1848–'9; Pichon, 1854; Fox, 1875; Siemens, 1879; Bradley, 1883; Cowles, 1885; Heroult, 1886, and Moissan, 1892–'5.

Dr. Marcus Benjamin contributed a 'Sketch of Professor Josiah P. Cooke,' who, from 1849 until the time of his death in 1894, was Ewing Professor of Chemistry in Harvard University. The sketch was of special interest from the fact that the statements given were taken from a manuscript sent by Prof. Cooke to Dr. Benjamin some years ago. Besides his six years' interest in the great chemical inventions of his time, *i. e.*, friction matches, daguerreotypes and gun cotton, the development of the chemical department under his guidance was fully described. The first practical instruction in chemistry to undergraduates in our American colleges was given by Prof. Cooke. A laboratory was fitted up in a cellar room of University Hall, of Cambridge, and from this grew the present magnificent equipment. Dr. Benjamin discussed Prof. Cooke's chemical work, especially that on the atomic weight of antimony, and referred also to his writings, of which 'The New Chemistry' is probably best known.

A. C. PEALE,
Secretary.

BIOLOGICAL SOCIETY OF WASHINGTON, 254TH MEETING, JANUARY 25.

CHARLES T. SIMPSON presented a paper on *The Extra-limital Mississippi Basin Unios.*

The speaker stated that the Unione fauna of the Mississippi basin was one in which the species were finely developed, often large or solid, richly sculptured or colored. The fauna of the Atlantic region consisted of smaller, less finely developed forms. The boundary between these regions on the north and northeast is not at the Height of Land, but far to the northward. Some 40 or more species of Mississippi naiades are found extra-limital in the northern and Atlantic drainage, while probably but a single Atlantic drainage form inhabits the Mississippi Valley. He believed this distribution was caused by the fact that at the close of the Glacial Epoch the northern lakes overflowed into the Mississippi Valley, and the Mississippi basin species ascended by way of these old streams into the British possessions.

These extra-limital forms were generally smaller and thinner, less highly colored, and

less strongly sculptured than when found in southern waters, and on these geographical variations a large number of species had been founded. Most of these are merely varieties of well-known Mississippi basin forms; a few have, perhaps, developed into good species. He believed these changes had all been wrought since the close of the ice age.

Similar changes on a larger scale had apparently taken place in the closely related unione fauna of the Atlantic drainage system, which, he believed, had been for the most part derived from the fauna of the Mississippi Valley, though at an earlier date.

M. B. Waite described the *Life History of the Pear-blight Microbe, Bacillus amylovrous.* The *Bacilli* first attack the blossoms and other new growth in spring. They multiply in the nectar of the blossoms and are able to enter the tender tissues of the nectar disk without a puncture. The germs are spread with great rapidity in the orchards during blossom time by bees and other insects. New infections take place on the tips of growing twigs or on newly opened leaf buds as well as on the blossoms, and may occur at any time that new growth is pushing out.

The majority of cases of blight come to a standstill after running their course, the twigs dry up and the germs all die in a week or two of exposure to summer weather, for this *Bacillus* forms no spores and cannot withstand drying. Some of the cases of blight do not, however, come to a standstill but continue slowly through the summer. Again, late growth in autumn often results in new infections, so that the trees go into their winter condition with active germs in them. These cases keep the Bacilli alive, and the speaker had been unable to find the germs living over winter in any other way. These cases of 'hold-over' blight are the key to the pear-blight question, for by cutting them out and destroying them when the tree is in a dormant or semi-dormant condition we can exterminate the microbes and prevent or control the disease.

Pierre A. Fish spoke of *the Action of Electricity upon Nerve Cells*, stating that Hodge's experiments have shown that certain well-defined changes occur in the structure of the nerve cell as a result of the stimulation of the nerves by weak electric currents. A strong current, on the contrary, such as is used in electrocutions, seems to cause no visible change, apparently killing and fixing the protoplasm in a manner analogous to that produced by histological reagents.

He gave the results of the examination of nervous tissue from three electrocuted subjects: In No. 1 a portion of the myel was examined, particularly the motor cells, and the cytoplasm in most cases showed numerous vacuoles. In No. 2 normal cells were the rule, and vacuoles the exception in the cervical myel. A small portion of the cortex from the precentral gyre (the region nearest the electrode) showed vacuolation of the large and small pyramidal cells, either in the cell body, or in the peripheral process. In No. 3 a small portion of the cerebellum only was obtained, and after careful search vacuoles were found in two Purkinje cells.

As vacuolation of the nerve cell is often the result of disease, an examination of plenty of material and a knowledge of the previous history of the individual is essential for a solution of the question of the action of electricity.

C. Hart Merriam read by title a *Revision of the Lemming-Voles* (*genus Synaptomys*).

Mr. Vernon Bailey read a paper entitled *Tamarack Swamps as Boreal Islands.* He stated that the common Eastern tamarack (*Larix americana*) is generally considered a boreal tree. East of the Rocky Mountains it overreaches the Boreal Zone, and occurs in scattered swamps throughout the transition and even in the northern part of the Upper Austral Zone. Such swamps are common in central Pennsylvania, northern Ohio, southern Michigan and northern Indiana, though the line marking the southern limit of the Boreal Zone is drawn much farther north. Within a radius of ten miles from Ann Arbor, Mich., which is in the Upper Austral Zone, are at least a dozen such swamps, ranging in size from a few acres to a mile square.

The vegetation of these swamps is composed largely of boreal species of plants, including the white birch, cassandra, andromeda, cranberries, pitcher plants, many species of northern grass, carex, herbaceous plants, mosses and a carpet

of sphagnum, 5 to 8 inches thick, as porous and absorbent as a sponge. The stem and leaves of sphagnum have a peculiar porous structure, through which a constant flow of water is carried up and poured out to evaporate on the surface. Thus by constant evaporation the plant and its surrounding atmosphere are kept cold. Ice was found under the sphagnum in one of these swamps as late as May 10, although the preceding winter had been mild and the snow had all disappeared by the middle of March. A number of small shrews (*Sorex personatus*), a boreal species of a boreal genus, were taken in one of these swamps, some being caught in traps resting on ice. The star-nosed mole, another boreal mammal, also occurs in some of these swamps, and the varying hare (*Lepus americanus*) was formerly common.

Evidently these boreal species of plants and animals are retained in the Southern swamps by the low temperature produced by evaporation from the sphagnum.

F. A. LUCAS,
Secretary.

GEOLOGICAL CONFERENCE OF HARVARD UNIVERSITY, JANUARY 21, 1896.

On the Origin of the Copper Deposits of Keweenaw Point: By PROF. H. L. SMYTH.

After a brief review of the character and structure of the rocks of the Keweenawan Series, and the geological and geographical distribution of copper in them, the author pointed out the close genetic connection between the three forms of occurrence of copper in this district. The amygdaloid and conglomerate 'floors' in the vein mines are essentially the same except in scale, as the greater impregnated and replaced amygdaloids and conglomerates. From this consideration all would date from the time of formation of the fissures of the vein mines; this was probably the time of general tilting, and long subsequent to the formation of the lower flows and conglomerates.

Pumpelly worked out many years ago a paragenetic series among the mineral associates of the copper; this series cleaves along a chemical line. The earlier minerals, which preceded the copper, are chlorite mainly, with certain other non-alkaline hydrous silicates; the latter are alkaline, and are close contemporaries of the copper. Among them are apophyllite (a fluorine mineral), and datolite (a boron mineral). Calcite is abundant through the whole series.

The author pointed out that from the consideration of the conditions of formation of the separate flows, with their subordinate intercalated conglomerates, each after consolidation was immediately subjected to the action of meteoric waters. Afterwards, by slow subsidence, each bed would eventually sink beneath their reach. The minerals of the first division of Pumpelly's series, essentially weathering products, belong to the successive periods of exposure of individual beds. The observed progress of alteration, from top to bottom in each individual bed, accords with this view, as do also the non-alkaline alteration products.

Afterwards came the northerly and northwesterly tilting, and the formation and filling of the fissures, and the impregnation and partial replacement of the amygdaloids and conglomerates. The new minerals of this period are sharply separated from the alteration products of the first (which they often replace) by their richness in alkalis, and the presence of fluorine and boron. The two periods, therefore, are far separated in time as well as by the character of the chemical agents at work, and do not, as Pumpelly supposed, represent a continuous march of alteration.

The author then discussed the more immediate questions of origin, and concluded that neither Pumpelly's view, that the copper had been brought down from the sandstones of the upper division of the series, nor Wadsworth's, that it had come from the lava-flows themselves, was probable. On the other hand, the mineral associates of the copper, the time of formation, and, in the case of the veins, the evident arrest of the copper-bearing solutions below the relatively impervious greenstone, all pointed to a deep-seated source and to ascending solutions as the transporting agent.

As to the precipitating agent, the author could not accept the view that it was electrolytic in its nature, because the deposition was manifestly accompanied in so many cases by the chemical destruction of the cathode. It was concluded that in spite of lack of confirmation by laboratory experiment, no theory so well ex-

plained the invariable deposition of metallic copper to great depths as Pumpelly's, viz: that it was effected by the reduction of copper salts by the FeO in the universally present chlorite.

T. A. Jaggar, Jr.,
Recording Secretary.

ST. LOUIS ACADEMY OF SCIENCE.

At the meeting of February 3, of the Academy of Science of St. Louis, President Gray in the chair and twenty-two other persons present, Mr. Trelease exhibited several specimens, about three feet square, of a curious silk tapestry, taken from the ceiling of a corn storing loft in San Luis Potosi, Mexico, by Dr. Francis Eschauzier, stating that he was informed that the larger specimen had been cut from a continuous sheet over twenty yards wide and about four times as long. The specimens, of a nearly white color, and of much the appearance and feeling of a soft tanned piece of sheepskin, were shown to be composed of myriads of fine silken threads, crossing and recrossing at every conceivable angle, and so producing a seemingly homogeneous texture. Although specimens of the creatures by which they are produced had not been secured, it was stated that there was no doubt that these tapestries are the work of lepidopterous larvæ which feed upon grain, the presumption being that they are made by the larvæ of what has been called the Mediterranean Grain or Flour Moth (*Ephestia Kühniella*). The speaker briefly reviewed the history of this insect and its injuriousness in various parts of the world, and quoted from a report of Dr. Bryce, showing that in Canada, where it became established in 1889, 'a large warehouse, some 25 feet wide, 75 feet long, and four stories high, became literally alive with moths in the short course of six months.'

One name was proposed for active membership.

William Trelease,
Recording Secretary.

NEBRASKA ACADEMY OF SCIENCES.

The fifth annual meeting was held in Lincoln January 2 and 3, at which a considerable number of papers were presented.

Dr. C. E. Besssy discussed the peculiar conditions by which the Buffalo grass had developed here on the plains from the nearly related Gramma grasses; and also the origin of the present flora of Nebraska in general.

Prof. C. D. Swezey showed by a comparison of early rainfall records in Nebraska with those of recent years that there is no evidence of any progressive change of our climate either towards greater rainfall or towards droughty conditions.

Mr. H. S. Clason presented facts dealing with the primitive civilization in America as indicated by the character of the ruins left.

Prof. F. W. Card showed how much less important were the economic fungi of the West than in the East, owing to our drier climate.

Dr. H. B. Ward described some new and little known animal parasites from Nebraska.

Mr. C. J. Elmore described some fossil diatoms from the State, and Dr. E. H. Barbour gave some facts as to the occurrence of considerable deposits of these organisms, such as give promise of commercial value.

Mr. G. A. Loveland presented an analysis of wind velocity records in the State to show how many hours a day the wind may be depended on for windmill power.

Dr. E. H. Barbour made a report of progress on the peculiar fossil Dæmonelix, of which he has now obtained a series of forms from successive horizons, indicating its probable genesis and development.

Lincoln, Neb., February 4, 1896.

G. D. Swezey,
Secretary.

NEW BOOKS.

A New View of the Origin of Dalton's Atomic Theory. Henry E. Roscoe and Arthur Hardey. London and New York, Macmillan & Co. 1896. Pp. ix + 190. $1.90.

The Number Concept, Its Origin and Development. Levi Leonard Conant. New York and London, Macmillan & Co. 1896. Pp. vi + 218. $2.00.

The Spraying of Plants. E. G. Lodeman. New York and London, Macmillan & Co. 1896. Pp. xvii + 399. $1.00.

La Théorie Platonicienne des Sciences. Élie Halévy. Paris, Alcan. 1896. Pp. xl + 378.